

DAIRY LABORATORY EXERCISES

**ON MILK COMPOSITION
AND TESTS**

**H. C. TROY
T. J. McINERNEY**



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DAIRY LABORATORY EXERCISES

ON

TESTING AND COMPOSITION OF DAIRY PRODUCTS

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PREFATORY NOTE

This book is intended to provide an outline of exercises for students in dairy industry. It is not intended that it should serve as a text book.

The exercises in Part I may be used in all schools and colleges as an introductory course on the testing and composition of dairy products.

The exercises in Part II are intended to serve as an advanced course for those specializing in dairy work and food control work.

Ithaca, N. Y., October 1st, 1921.

Dairy Laboratory Exercises

GENERAL COMPOSITION OF MILK

The fluid normally secreted in the mammary gland of female mammalia is called milk. In defining the standards of purity for dairy products the Association of American Dairy, Food and Drug Officials adopted the following definition of milk on August 3rd, 1917:—

“Milk is the whole, fresh, clean lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before and five days after calving, or such longer period as may be necessary to render the milk practically colostrum-free.”

The six main constituents of milk and their approximate percentage is shown in the following chart:—

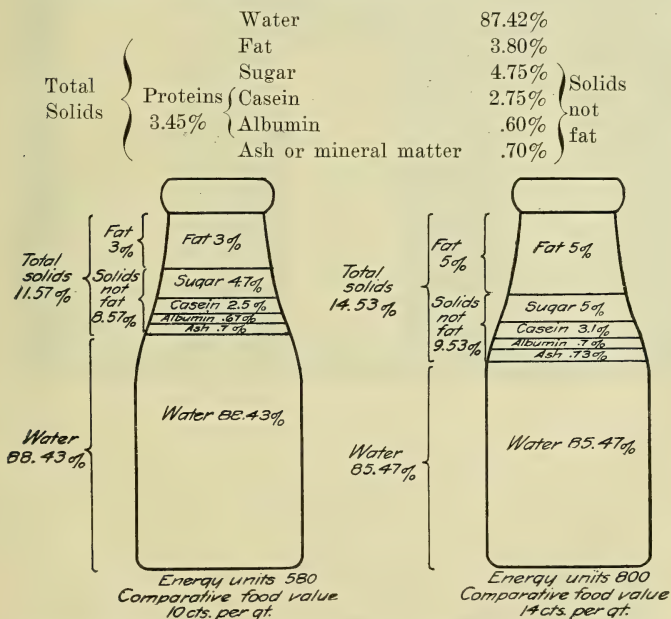
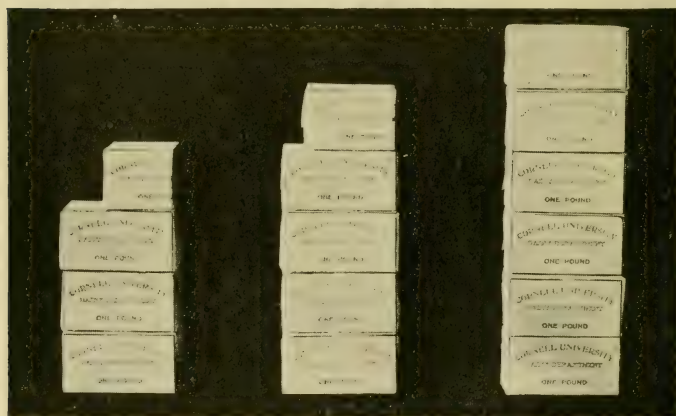


FIG. 57. COMPARISON OF AVERAGE COMPOSITION AND FOOD VALUE OF MILK CONTAINING THREE AND FIVE PER CENT OF FAT

The difference in the food values of equal quantities of milk containing different percentages of fat is shown in figure 57. A 1-per-cent increase in the percentage of fat in normal milk indicates about a 20-per-cent increase in the food value. Thus when a quart of milk containing 3 per cent of fat is worth 10 cents, a quart containing 4 per cent is worth 12 cents, and a quart containing 5 per cent is worth 14 cents. These facts have not been generally understood in the past, and have not received sufficient attention in the retail marketing of milk. They point out the importance of the fat test.

One hundred pounds of milk containing 3 per cent of fat will make about 3.6 pounds of butter, while the same weight of milk



A

B

C

FIG. 58. AMOUNT OF BUTTER MADE FROM ONE HUNDRED POUNDS OF MILK CONTAINING VARIOUS PERCENTAGES OF FAT

A, one hundred pounds of milk containing 3 per cent of fat made 3.6 pounds of butter; B, one hundred pounds of milk containing 4 per cent of fat made 4.8 pounds of butter; C, one hundred pounds of milk containing 5 per cent of fat made 6.0 pounds of butter

containing 5 per cent of fat will make 6 pounds of butter (fig. 58.) This shows the importance of testing milk when calculating its butter-making value. The increase in the number of pounds of butter over the number of pounds of fat in the milk or the cream

is called the overrun and it is due to the water, the salt, and the casein that remain in the butter when the churning process is completed. One hundred pounds of butter of average composition contains about 82 pounds of fat, 14.5 pounds of water, 2.5 pounds of salt, and 1 pound of casein.

The percentage of fat in milk also indicates its cheese-making value. Thus while 100 pounds of milk containing 3 per cent of fat will make on an average about 8.3 pounds of cheese, the same amount of 4-per-cent milk will make 10.6 pounds, and a like amount of 5-per-cent-milk will make 12.9 pounds.

Fat exists in milk in the form of very small globules. With the aid of a high-power microscope they may be seen floating in the liquid. Since the fat globules are lighter than the other milk constituents, most of them rise to the surface under the influence of the force of gravity. There, mixed with other milk substance, these globules form a layer of cream.

When sulfuric acid of proper strength and temperature is added to milk, as in the Babcock fat test, the milk sugar, and the protein are decomposed, and the sticky quality of the milk is destroyed. The acid does not, however, decompose the fat, but leaves it free to come to the surface of the mixture under the influence of centrifugal force generated in the testing machine.

FAT VARIATIONS IN MILK

The fat in milk commonly varies between three and six per cent. These variations come from several causes. One of the most important is the breed of the cows; another is the difference between individuals of the same breed. The percentage of fat in the milk of an individual in extreme cases may average either one per cent above or one per cent below the breed average. Also, the percentage of fat is affected by the length of time since the cow has freshened. It is a well-known fact that toward the end of the lactation period, when the cow is being dried off, the milk contains a higher percentage of fat than it did earlier in the season. It is also fairly well established that, when the time elapsing between milkings is not of equal length, the milk drawn after the longer period contains the lower percentage of fat. There are also minor influences affecting the fat content, such as feverish condition of the animal, or overexcitement due to dog-

ging or other ill treatment that might cause the cow to hold up part of her milk, thus giving a larger portion of the milk that is first let down, which is not so rich in fats as the strippings. The character of the food of an animal has very little effect on the percentage of fat in the milk, altho it has a marked effect on the amount of milk and fat produced.

FAT PERCENTAGE AND FOOD VALUE

When measured by energy units, the fat supplies about one-half of the food value of average milk, and the solids not fat furnish the other half. The solids not fat are composed of milk sugar (lactose), casein, albumin, and mineral matter (ash).

Recently it has been discovered that milk also contains two very important growth-promoting and health-regulating principles, known as *vitamines*.

The principal proteins in fresh milk are calcium caseinate, lactalbumin and lactoglobulin. The casein is not in true solution but is evenly distributed throughout the mass of milk in minute gelatinous particles known as a colloidal condition. The casein assists in retarding the rise of fat globules and is largely accountable for the opaque, nearly white color of milk. In fresh milk it is not precipitated by boiling but is thrown down by dilute acids while strong mineral acids dissolve and decompose it. Milk albumin is present in true solution. It is not precipitated by dilute acids but is thrown down by heating milk to a temperature of about 80° C. Lacto-globulin is present in milk only in traces.

Milk sugar forms about 58 to 60 per cent of the solids not fat. It is valuable chiefly as a food, having the same energy and heat producing power as cane sugar but it is not so sweet. It is converted to lactic acid by bacterial action and its presence in the digestive tract is thought to assist digestion. The importance of milk sugar is also increased since lactic acid and its control plays an important part in the manufacture, quality and preservation of milk products.

The ash is the substance derived from the mineral salts of milk that remain when dried milk is burned to a white ash at a low red heat. The mineral salts in milk consist chiefly of potassium, sodium, calcium and magnesium in the form of chlorides, phosphates and citrates. The high calcium content gives the mineral salts of milk special value as a food.

THE BABCOCK FAT TEST

Previous to the year 1890 comparatively few people knew anything about the composition of milk or the percentage of fat it contained. Dairy products were bought and sold by weight or measure almost regardless of their composition or food value. In 1890 Dr. S. M. Babcock of the Wisconsin Agricultural Experiment Station invented the milk fat test that bears his name and published a report on it. By the application of this test, or slight modifications of it, the approximate percentage of fat in nearly all dairy products may be determined.

TESTING MILK

Sampling the Milk. If the milk is fresh and no cream has risen on it, the sample shall be taken immediately after pouring the milk from one vessel to another three or four times. Where such milk cannot be poured, it should be thoroughly and vigorously stirred for at least half a minute with some suitable instrument long enough to reach the bottom of the container.

If the cream has risen on the milk, or if a layer of cream has formed, mixing must be continued until all cream is detached from the vessel and all particles of cream are broken up and evenly distributed throughout the mass and no longer are visible on close observation.

In taking composite samples, a **porportionate** amount of each mass of milk sampled should be placed in the composite sample bottle. This can usually be done best by means of a sampling tube. At least ten cubic centimeters of milk should be taken from each mass of milk sampled. A composite sample, as referred to here, means a sample of milk made up of proportionate amounts of each delivery from a single source, to be tested for fat content. A composite sample should not represent milk delivered for a period of more than 16 days. A herd sample taken one day during the period cannot be considered a composite sample of such period.

Care of the Milk Sample. Composite samples in order to give satisfactory results, should be kept in a shaded place in clean, air-tight jars and should contain a sufficient amount of preservative. Corrosive sublimate or potassium bichromate shall be used as preservatives, care being taken not to use excessive

amounts. Care also should be taken to keep such samples in a cool place, but they should not be allowed to freeze.

If transported by mail, express or otherwise, the sample bottle should be completely filled, tightly stopped and sealed.

Immediately before testing, the sample must be mixed gently until it is homogeneous. Composite or other than fresh samples must be placed in water warm enough to soften all lumps of cream and cream attached to the inside of the jar. Then mix gently until the sample is homogeneous and pipette at once, using 18 grams of milk. Avoid incorporating air bubbles while mixing the sample. Curdy and churned samples are not dependable.



FIG. 61. CORRECT POSITION OF THE PIPETTE AND TEST BOTTLE WHILE TRANSFERRING THE MILK

Operation: Mix the milk by pouring, allowing it to flow down the side of the vessels to avoid incorporating air bubbles. Vigorous shaking should be avoided. See that all cream is removed from the sides of the sample bottle and that it is evenly distributed thruout the milk. Then holding the pipette between the thumb and the second finger of the right hand, place its tip well under the surface and draw in the milk by suction with the lips on the upper end until it is filled well above the graduation. Quickly place the fleshy pad of the forefinger over the

opening and at right angles to the pipette. By rolling the pipette a little between the thumb and the second finger sufficient air will enter to allow the milk to run out slowly until the upper surface

is exactly level with the graduation. The pipette should be held perpendicular, with the graduation on a level with the eye.

Hold the milk test bottle in a slanting position and place the tip of the pipette into it about one-third of an inch and at a slight angle (fig. 61). Allow the milk to flow slowly down the side of the bottle neck, making certain that none is blown out by the escaping air. Blow the drop that remains at the tip of the pipette into the test bottle. Measure out another test sample in the same manner, as the test must be made in duplicate.

Adding the Acid: Fill the measure to the mark with acid,

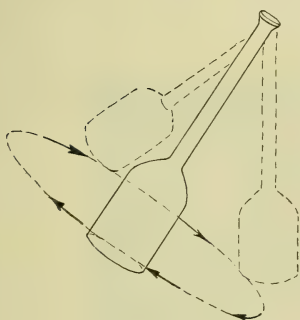


FIG. 62. DIAGRAM SHOWING THE MOTION AND POSITION OF A TEST BOTTLE WHILE MIXING THE MILK AND THE ACID

and then rotate the test bottle slowly while adding the acid so that it will rinse down any milk remaining in the neck. Immediately mix the acid and the milk thoroly by whirling the body of the bottle in a circle five or six inches in diameter (fig. 62), using care to keep the mixture out of the neck of the bottle. Shake the mixture vigorously for about one minute after all curd has disappeared, and shake it again just before centrifuging to insure complete solution. Avoid pointing the neck of the bottle toward any person during the

mixing operation and so prevent the possibility of having acid thrown into the eyes or on the clothing. The acid unites with all of the milk substances except the fat, thus generating much heat. The temperature of the mixture usually rises to 225° F.

Centrifuging: Steam driven centrifuges will be warm enough. Hand or electrically driven centrifuges are heated either by placing on a stove or by adding a few quarts of boiling water. A corked opening in the bottom provides a means of removing the water.

The disk of the machine must be balanced by placing test bottles in exactly opposite pockets. Cover the machines before starting.

Table showing the revolutions per minute the bottles should make while whirling in Babcock testers:

10 inch disks.....	1,100 revolutions
12 inch disks.....	1,000 revolutions
14 inch disks.....	925 revolutions
16 inch disks.....	850 revolutions
18 inch disks.....	800 revolutions
20 inch disks.....	760 revolutions
22 inch disks.....	725 revolutions
24 inch disks.....	700 revolutions

The diameter of the disks may be determined by measuring the distance between the bases of bottles in opposite cups when they are in a horizontal position.

After whirling the bottles for five minutes, stop, and, without removing the bottles from the pockets, fill them nearly to the base of the neck with water that is nearly boiling hot. The pipette or a tin cup with a slender spout may be used for this

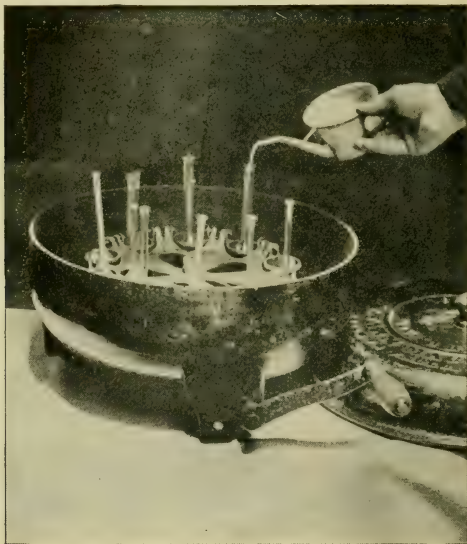


FIG. 63. POURING THE HOT WATER INTO THE BOTTLES

purpose (fig. 63). Whirl the bottles again for two minutes in order to wash any sediment from the fat. Again add hot water to the test bottles until the top of the fat column is a little

below the highest graduations on the scale. Whirl the bottles for one minute, and take the readings immediately. If the tests are not read immediately, they should be held at a temperature between 130° and 140° F. either by keeping the centrifuge hot and covered or by placing the test bottles in water at that temperature and deep enough to surround the fat columns.

Reading the Percentage of Fat: Subtract the reading on the scale at the base of the fat column from the reading at the highest point at the top of the fat column (fig. 64.) The difference is the percentage of fat in the milk. Thus, if the scale at the base of the column reads 1.7 and at the top reads 5.8, then 5.8 minus 1.7 equals 4.1, the percentage of fat in the milk. The curved surface called the meniscus, which always exists at the top of the fat column, must be included in the reading, as it is just large enough to make up for a small amount of fat remaining down in the body of the bottle. The limit of error for the test is usually less than .2 of 1 per cent. When such a difference occurs in a duplicate test, the average of the duplicate readings should be taken.

TESTING CREAM

Sampling: Cream differs from milk by containing a higher percentage of fat. Cream containing 30 per cent of fat would contain 70 per cent of skimmed milk substance, or milk serum. Before sampling, the fat should be evenly distributed by thoro mixing or pouring. If the cream is old or lumpy or some has dried on the container, it should be warmed to about 95° F. and the lumps should be passed thru a strainer before mixing. Then about two ounces should be placed in the sample bottle.

Operation: The test sample must be weighed instead of measured because:

1. The percentage of fat and the specific gravity of cream vary widely, and the weight of a definite volume would vary accordingly.
2. Cream may contain bubbles of air or of carbon dioxide.
3. Cream varies so widely in viscosity (sticky quality) that

the amount delivered or the amount remaining in the pipette would be unknown.

In testing cream 9 grams is used. Balance the bottle on the scales, and place a 9-gram weight on the opposite side. Mix the sample thoroly, and by means of a pipette transfer cream to the test bottle until the scales exactly balance. Next add about 9 cubic centimeters of water to the test bottle. This water may be measured with sufficient accuracy in the acid measure by filling it a little over halfway to the mark. Add about 15 cubic centimeters of the acid to the test bottle, and mix the contents thoroly. The cream and acid mixture should not turn black, but should remain coffee color. About 15 cubic centimeters of acid gives the proper concentration to dissolve the solids not fat, since the fat forms such a large part of the mixture and does not go into solution. Centrifuge the bottles, and add the water exactly as in testing whole milk.

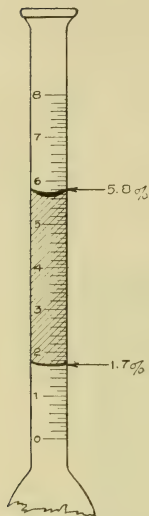


FIG. 64. METHOD OF READING THE PERCENTAGE OF FAT IN MILK

The arrows indicate the points on the scale at the ends of the fat column at which the readings should be taken

Tempering the Fat and Reading the Percentage: When the last whirling is completed, transfer the test bottles to the tempering vat containing water held at a temperature of 140° F. The water should be tempered in advance, and it should be deep enough to surround the necks of the bottles to the top of the fat columns. After four minutes take the bottles from the water, and add the meniscus remover at once by placing the tip of a dropping pipette containing some of the substance against the inside of the neck of the bottle,

which is held in a slightly slanting position. The red liquid is allowed to run slowly down the inside of the neck and spread over the fat to a depth of about one-fourth of an inch. It should not mix with the fat. Read the test immediately by subtracting the number on the scale at the bottom of the fat column from the number on the scale at the line of division between the fat and the meniscus remover (fig. 65). Thus if the bottom line of

the fat column reads 12 and the line between the meniscus remover and the fat at the top reads 39, the percentage of fat would be 27.

In testing milk the meniscus should be included in the reading as it is just sufficient to make up for the fat that is not brought up by the test. But the volume of the meniscus on the cream test is much larger than the one on the milk test, while the amount of impurities in the larger volume of fat in the cream test is about sufficient to make up for any fat remaining down in the bottle.

Therefore, the meniscus on the cream test should be removed before reading the percentage of fat.

APPEARANCE OF A COMPLETED TEST

In a completed test the fat should be straw-yellow in color; the ends of the fat column should be clearly and sharply defined; the fat should be free from specks and sediment; the water in the neck just below the fat should be clear; and the fat should be in the graduated part of the neck. Some of the defects and remedies are explained in the following paragraphs.

If the fat column is too dark in color, the acid may have been too strong, or too much may have been used, or the temperature of the milk and the acid may have been too high just before mixing. Mixing too slowly might also permit charring of part of the fat. The charred or darkened condition of the fat may be corrected to some extent by using less acid, by cooling both milk and acid below 60° F. just before mixing, and by rapid vigorous mixing continued for about a minute after all casein has been dissolved.

If the fat column is too light in color, the acid was either too weak or too

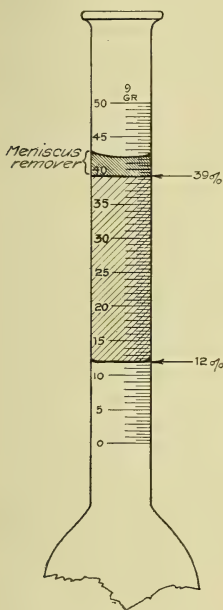


FIG. 65. METHOD OF READING THE PERCENTAGE OF FAT IN CREAM

The arrows indicate the points on the scale at the ends of the fat column at which the readings should be taken

cold. This condition may be corrected to some extent in succeeding tests by using more acid and by having the milk and the acid at a little higher temperature when brought together.

If the acid is not of the correct strength (specific gravity 1.82 to 1.83), it will be difficult to get a correct test, but the trouble may be partially overcome by using more acid when it is weak and less when it is too strong.

TESTING SKIMMED MILK AND BUTTERMILK

The skimmed milk test bottle (fig. 66) is also used in testing buttermilk, and the operation is the same for each substance. The graduated neck of the skimmed milk test bottle has a very small bore in order to measure the fat accurately. A second neck with larger bore is attached to provide a convenient means of filling the bottle. The smallest divisions on the scale usually indicate .01 of 1 per cent, but on some bottles they indicate .05 of 1 per cent.

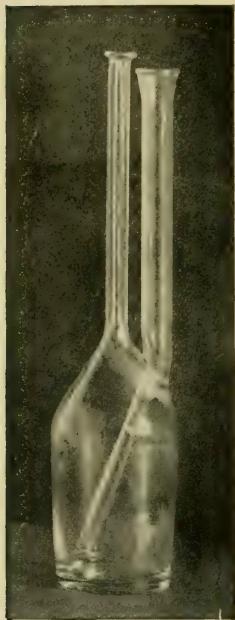


FIG. 66. SKIMMED MILK TEST BOTTLE

The same care is necessary in mixing and sampling skimmed milk and buttermilk that is required for whole milk, and the same pipette is used in measuring out the sample. The skimmed milk is added to the test bottle thru the larger neck. Since a little more acid is necessary to thoroly free the fat in skimmed milk, 23 to 25 cc. should be used. First add about one-half of the acid, and shake the mixture thoroly; then add the remainder, and again shake it vigorously for about a minute. Avoid throwing undissolved casein into the small neck while mixing the milk with the acid. The bottles are then centrifuged and filled in the same manner as in testing whole milk, except that the first whirling should be continued for ten minutes, instead of five, in order to bring up all the smaller fat globules. The percentage of fat is read immediately on completing the final whirling.

WASHING BABCOCK GLASSWARE

Wash the glassware thoroly between each test. Any fat remaining in the test bottles would increase the following test. First empty the contents of the test bottles on an ash heap or some place where the mixture will not come in contact with the food or the feet of animals. Do not empty the mixture into ordinary sinks or drains because the acid solution will destroy the sink and piping. Then rinse out the bottles with hot water. Add a strong hot solution of a good washing powder until the bottles are half full. Shake them vigorously while emptying them, and pass a small brush thru their necks; then rinse them again using plenty of hot water. The bottles will then be ready to use in another test.

The pipette should be rinsed out with water immediately after measuring out the samples, for if the milk is allowed to dry, it will be difficult to clean the instrument. It should also be washed with the hot soap solution when the bottles are being washed, and well rinsed afterward.

A simple tray for holding test bottles while carrying or washing them is made by boring twelve or fourteen holes, to fit the bottoms of the bottles, nearly thru a piece of plank 12 inches long, 6 inches wide, and 1.5 inches thick. A cover a half an inch thick is made with corresponding holes. The holes in the cover should be large enough to permit the necks of the bottles to pass thru, but not the bodies.

When several bottles are to be emptied and washed, they may be placed in the block and the cover placed down over them. By holding the block and cover together at each end, several bottles may be shaken or emptied as quickly as one.

THE SPECIFIC GRAVITY OF MILK

When equal volumes of milk and water are weighed, it will be found that the milk is heavier. A vessel that holds 1000 grams of water will hold 1032 grams of average milk; or for each gram of water there would be 1.032 grams of milk. $1032 \div 1000 = 1.032$. Therefore 1.032 equals the specific gravity of milk since it is the existing ratio between the weights of equal volumes of milk and the standard substance water. One cubic centimeter of water at the proper temperature (4° C., or 39.2° F.) weighs one gram.

THE PIPETTE

The Babcock pipette used in measuring milk test samples delivers 18 grams of milk. $18 \div 1.032$ (the specific gravity of milk) = 17.44, the cubic centimeters of milk delivered into the test bottle. The pipette is made to hold 17.6 cubic centimeters because it has been found by experiment that the difference between 17.6 cubic centimeters and 17.44 cubic centimeters, or .16 cubic centimeter, remains in the pipette.

THE MILK TEST BOTTLE

When the Babcock test was first invented, the scale on the neck of each test bottle was graduated to read from 0 to 10 per cent. The smallest graduations indicated .2 of 1 per cent. In recent years preference has been given to a test bottle that has a scale in which the smallest divisions indicate .1 of 1 per cent. The scale on this bottle reads from 0 to 8 per cent. Both forms of bottles are in use at the present time.

The graduated portion of the 10-per-cent bottle holds 2 cubic centimeters. One cubic centimeter of butterfat at a temperature of 140° F. weighs .9 of a gram. Therefore if the graduated portion of the neck of the milk test bottle were full of fat, it would contain 1.8 grams. That would be 10 per cent of 18 grams. $1.8 \div 18 = .10$. $.1 \times 100 = 10$ per cent. Eighteen grams is the weight of the milk placed in the test bottle. When 2 cubic centimeters, the volume in the graduated part of the neck, is divided into ten equal parts, one part equals one per cent.

SPECIFICATIONS AND DIRECTIONS FOR TESTING MILK
AND CREAM FOR BUTTERFAT

Official Dairy Instructors' Association, 1916.

I. APPARATUS AND CHEMICALS

Milk test bottle.—8 per cent 18 gram milk test bottle, graduated to 0.1 percent. Graduation. The total per cent graduation shall be 8. The graduated portion of the neck shall have a length of not less than 63.5 mm. (2½ inches). The graduation shall represent whole per cent, five-tenths per cent and tenths per cent. The tenths per cent graduations shall not be less than 3 mm. in length; the five-tenths per cent graduations shall be 1 mm. longer than the tenths per cent graduations, projecting 1 mm. to the

left; the whole per cent graduation shall extend at least one-half way around the neck to the right and projecting 2 mm. to the left of the tenths per cent graduations. Each per cent graduation shall be numbered, the number being placed on the left of the scale.

The maximum error in the total graduation or in any part thereof shall not exceed the volume of the smallest unit of the graduation.

Neck. The neck shall be cylindrical and of uniform internal diameter throughout. The cylindrical part of the neck shall extend at least 5 mm. below the lowest and above the highest graduation mark. The top of the neck shall be flared to a diameter of not less than 10 mm.

Bulb. The capacity of the bulb up to the junction of the neck shall not be less than 45 cc. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be between 34 and 36 mm.; if conical, the outside diameter of the base shall be between 31 and 33 mm., and the maximum diameter between 35 and 37 mm.

The charge of the bottle shall be 18 grams.

The total height of the bottle shall be between 150 and 165 mm. ($5\frac{7}{8}$ and $6\frac{1}{2}$ inches).

Cream test bottle 1.—50 per cent 9 gram short-neck cream test bottle, graduated to 0.5 per cent. Graduation—The total per cent graduation shall be 50. The graduated portion of the neck shall have a length of not less than 63.5 mm. ($2\frac{1}{2}$ inches). The graduation shall represent 5 per cent, 1 per cent, and 0.5 per cent. The 5 per cent graduations shall extend at least half-way around the neck (to the right). The 0.5 per cent graduations shall be at least 3 mm. in length, and the 1 per cent graduations shall have a length intermediate between the 5 per cent and the 0.5 per cent graduations. Each 5 per cent graduation shall be numbered, the number being placed on the left of the scale.

The maximum error in the total graduation or in any part thereof shall not exceed the volume of the smallest unit of the graduation.

Neck. The neck shall be cylindrical and of uniform internal diameter throughout. The cylindrical part of the neck shall extend at least 5 mm. below the lowest and above the highest

graduation mark. The top of the neck shall be flared to a diameter of not less than 10 mm.

Bulb. The capacity of the bulb up to the junction of the neck shall not be less than 45 cc. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be between 34 and 36 mm.; if conical, the outside diameter of the base shall be between 31 and 33 mm. and the maximum diameter between 35 and 37 mm.

The charge of the bottle shall be 9 grams. All bottles shall bear on top of the neck above the graduations, in plainly legible characters, a mark defining the weight of the charge to be used (9 grams).

The total height of the bottle shall be between 150 and 165 mm. ($5\frac{7}{8}$ and $6\frac{1}{2}$ inches), same as standard milk test bottles.

Cream test bottle 2.—50 per cent 9 gram long-neck cream test bottle, graduated to 0.5 per cent. The same specifications in every detail as specified for the 50 per cent 9 gram short-neck bottle shall apply for the long-neck bottle with the exception, however, that the total height of this bottle shall be between 210 and 235 mm. ($8\frac{1}{4}$ and 9 inches), that the total length of the graduation shall be not less than 120 mm., and that the maximum error in the total graduation or in any part thereof shall not exceed 50 per cent of the volume of the smallest unit of the graduation.

Cream test bottle 3.—50 per cent 18 gram long-neck cream test bottle, graduated to 0.5 per cent. The same specifications in every detail as specified for the 50 per cent 9 gram long-neck bottle shall also apply for the 18 gram long-neck bottle, except that the charge of the bottle shall be 18 grams. All bottles shall bear on top of the neck above the graduation, in plainly legible characters, a mark defining the weight of the charge to be used (18 grams.)

"Pipette, capacity 17.6 cc. of water at 20° C. Total length of pipette not more than 330 mm. ($13\frac{1}{4}$ inches). Outside diameter of suction tube 6 to 8 mm. Length of suction tube 130 mm. Outside diameter of delivery tube 4.5 to 5.5 mm. Length of delivery tube 100 to 120 mm. Distance of graduation mark above bulb 15 to 45 mm. Nozzle straight. To discharge when filled with water in 5 to 8 seconds. The maximum error shall not exceed 0.05 cc.

In the operation of the test the last drop of milk should be blown out of the pipette into the test bottle."

Acid measure, capacity 17.5 cc.

Cream testing scales. Sensibility reciprocal of 30 mgm., i. e., the addition of 30 mgm. to the scales, when loaded to capacity, shall cause a deflection of the pointer of at least one division on the graduation.

Weights, 9 gram weights for 9 gram cream test bottles and 18 gram weights for 18 gram cream test bottles, preferably stamped correct by the United States or State Bureau of Standards.

Tester. Standard Babcock test centrifuge and speed indicator.

Dividers for measuring fat column.

Water bath for cream samples, with proper arrangement for regulating and recording temperature of samples.

Water bath for test bottles, of sufficient size and with necessary equipment to insure proper control of temperature. The following dimensions for a twenty-four bottle water bath are recommended: Metal box, 14 inches long, 11 inches wide and $8\frac{1}{2}$ inches deep and equipped with a bottle basket $9\frac{1}{2}$ inches long and $6\frac{1}{2}$ inches wide, capacity twenty-four bottles, a steam and water inlet, a drain, a thermometer holder with thermometer.

Chemicals. Commercial sulphuric acid, specific gravity 1.82 to 1.83; glymol, or white mineral oil, high grade.

II. MANIPULATION OF TEST

A. Milk Test

Milk Samples. Single samples are preferred to composite samples. If composite samples are used they should be kept in clean jars sealed air-tight, and containing a sufficient amount of preservative. Corrosive sublimate, potassium bichromate and formaldehyde may be used as satisfactory preservatives. For the keeping of composite samples a cool location should be chosen. They should be the product of not over one week and should be tested as soon as possible.

If transported by mail, express or otherwise the sample bottle should be completely full and tightly stoppered and the samples should be preserved as above directed.

Immediately before testing the sample is thoroughly mixed until it is homogeneous. If lumps of cream, butter or ice do not completely disappear, heat to 100° to 120° F., mix thoroughly and

pipette at once. Avoid incorporation of air bubbles while mixing the sample. Curdy and churned samples are not dependable.

Testing. Measure 18 grams of milk from properly mixed sample into standard milk test bottle, by using 17.6 cc. standard pipette; add 17.5 cc. of standard commercial sulphuric acid, and shake until all curd has disappeared, and then continue the shaking for a few moments longer. Milk and acid before mixing should have a temperature of 50° to 70°F.

Whirl in Babcock centrifuge for five, two and one minutes, respectively, filling the bottle with hot soft water (temperature 140°F. or above) to the bottom of the neck after the first whirling and to near top graduation after the second whirling. The proper speed of the centrifuge is 800 revolutions for an 18 inch diameter wheel and 1000 revolutions per minute for a 12 inch diameter wheel.

Set the test bottles into water bath and read after a temperature of 135°F. to 140°F. has been maintained for not less than 3 minutes. Read test by measuring fat column from bottom of lower meniscus to top of upper meniscus. Use dividers for reading.

B. Cream Test

Cream samples. Cream samples should be tested as soon as possible and not later than three days after they are taken. Composite samples representing portions of consecutive deliveries of the same patron are unreliable. Samples should at all times be kept in nonabsorptive containers, sealed air-tight and held in the cold.

Immediately before testing mix the sample until it pours readily and a uniform emulsion is secured. If in good condition shake, pour or stir until properly mixed. If very thick, warm to 85°F. and then mix. In case of lumps of butter heat the sample to 100°F. to 120°F. by setting in water bath, mix thoroughly and weigh out at once. For commercial work on a large scale it is advisable to temper all samples to 100° to 120°F. in a water bath previous to mixing. Great care should be exercised to avoid overheating the sample, causing the cream to "oil off." This precaution is especially necessary with thin cream.

Testing. Weigh 9 grams or 18 grams, respectively, of the properly mixed sample into a standard cream test bottle on standard

cream testing scales which are in proper working condition, set level and are protected from drafts.

Method 1. Add standard commercial sulphuric acid until the mixture of acid and cream, immediately after shaking, resembles in color, coffee with cream in it. Usually about 8 to 12 cc. of acid is required in the case of the 9 gram bottle or 14 to 17 cc. of acid in the case of the 18 gram bottle, the amount needed depending on the temperature of acid and cream and on the richness of the cream.

Whirl in Standard Babcock centrifuge at proper speed, five, two and one minutes, respectively, filling the bottles with hot soft water, temperature 140 F. or above, to the bottom of the neck after the first whirling and to near the top graduation after the second whirling.

a. **Altenate Method.** Add 9 cc. of water after the cream has been weighed into the test bottle and before the acid is added, then add 17.5 cc. acid and proceed as in previous method. This method is applicable with the 9 gram bottle only.

b. **Alternate Method.** Add 8 to 12 cc. of acid in the case of the 9 gram bottle or 14 to 17 cc. of acid in the case of the 18 gram bottle, or add acid until the mixture of cream and acid, after shaking, has a chocolate brown color. After the cream and acid have been thoroughly mixed and all lumps have completely disappeared, add a few cubic centimeters (not less than 5 cc.) of hot soft water, whirl five minutes, add hot soft water to near top of scale and whirl one minute.

The proper speed of the centrifuge is 800 revolutions per minute for an 18 inch diameter wheel and 1000 revolutions per minute for a 12 inch diameter wheel.

Set the test bottles into water bath and read after a temperature of 135° F. to 140° F. has been maintained for not less than three minutes, add a few drops of glymol and read at once, preferably using dividers. Experienced testers are able to secure correct readings without glymol by reading to the bottom of the upper meniscus but the use of glymol is urged.

C. Defective Tests

The fat column of the finished test should be clear, translucent and should have a golden yellow to amber color. All tests which

are milky, or foggy, or showing the presence of curd or charred matter in or below the fat column, or of which the reading is indistinct or uncertain, should be rejected. Duplicate tests are essential in all work where special accuracy of results is required, such as official testing and experimental investigations.

EXERCISES

PART I

EXERCISE I

THE BABCOCK TEST

Special directions should be given to students by the instructor as to handling materials used in testing, laboratory technique and running the different centrifuges.

All glassware should be thoroughly cleaned before beginning the practice.

1. Test for fat by the Babcock method a sample of whole milk and a sample of skimmed milk.

2. Take the temperature of the milk before adding the acid. Take the temperature of the acid before adding it to the milk. Take the temperature of the mixture of acid and milk immediately after mixing. Complete the test record all readings of temperatures and fat percentages.

3. Using water in place of milk repeat the experiment up to the operation of centrifuging the bottles.

QUESTIONS

Note the weight of the volume of acid used as compared to the weight of the same volume of water. Note the color of the mixture in the bottle after the acid has been mixed with the milk.

Note the color of the fat in the completed test.

Note the graduations on the pieces of glassware used. Record all data.

Write a complete description of the Babcock test for fat in milk and skimmed milk.

Record at least five references on the Babcock test.

EXERCISE II

CONFORMITY OF BABCOCK GLASSWARE TO SPECIFICATIONS

I. Compare the measurements of one milk test bottle, one cream test bottle and one pipette with specifications, using a rule graduated in the metric system.

II. Make drawings of the above named pieces of apparatus and indicate measurements.

III. Using an alcoholic solution made by adding 10 cc. of alcohol to 90 cc. of water colored red with alkanet root, determine the capacity of the graduated neck of a ten per cent milk test bottle as follows: Fill the bottle to the zero graduation with water at room temperature. Fill an accurately graduated 10 cc. burette to the zero mark with the colored solution. Dry the neck of the test bottle by the use of narrow strips of blotting paper. Run the colored solution from the burette into the bottle neck, taking readings at each per cent graduation. Each per cent graduation should equal .2 cc. of the colored solution.

IV. Following the same directions determine the accuracy of calibration of an eight per cent milk test bottle, a six inch cream test bottle and a nine inch cream test bottle.

QUESTIONS

How would large variations in the diameters of the bore in different milk test bottles affect the accuracy of the fat percentage reading?

Give the legal requirements covering the use of Babcock glassware in your state.

What is the maximum error in the graduations on test bottles permitted by the specifications for Babcock glassware?

Name the apparatus and chemicals used in the Babcock test for which specifications are given by the Am. Dairy Sci. Ass.

Give the specification for chemicals.

EXERCISE III

ACCURACY OF CALIBRATIONS AND SPEED OF CENTRIFUGE

1. Fill a Babcock pipette to the graduation with water at a temperature of 60° F. Accurately weigh the amount of water it delivers.

Fill the same pipette with milk at 60° F. and accurately weigh the amount of milk it delivers.

In each case note the time required for the contents of the pipette to be delivered.

2. Using the Nafis bottle tester determine the accuracy of the graduations of one milk test bottle and one cream test bottle.

3. On a steam centrifuge determine the number of pounds of steam pressure, as indicated by the steam gauge, that will cause the disc to revolve (a) 800 revolutions per minute, (b) 1000 revolutions per minute for each steam centrifuge in the laboratory.

(See Farrington & Wall.)

QUESTIONS

1. Why is temperature of importance in determining the weight of definite volumes of liquids?

2. Why is there a difference in weight between equal volumes of milk and water?

3. In experiment I was there a difference in the length of time required for the milk and water to flow from the pipette. If so what caused this difference?

4. Give the precautions to be observed in using a Nafis bottle tester.

5. In steam centrifuges of the same size and style why may the pounds of pressure on the different steam gauges vary when all of the disks are revolving at the same speed.

6. Derive a formula for determining the speed of the disk of a Babcock centrifuge.

7. Define centrifugal force.

8. Why does the specific gravity of sulphuric acid vary?

9. Give the commercial name and the physical and chemical properties of sulphuric acid.

10. What is the relation between speed, centrifugal force and the diameter of the disc in the operation of the Babcock test?

EXERCISE IV

TESTING SKIM MILK AND CREAM

1. Test by the Babcock method a sample of whole milk, skimmed milk and cream.

2. Weigh into a convenient dish 20 grams of the cream just tested and add to it 18 grams (one pipette full) of the milk. Compute the percentage of fat in this mixture and verify your results by testing the sample in a cream test bottle.

3. Place 36 grams (two pipette fulls) of the milk used in experiment one in a convenient dish. Add to this 18 grams (1 pipette full) of the skimmed milk used in experiment one. Compute the percentage of fat in this mixture and verify your results by testing the sample in a milk test bottle.

QUESTIONS

1. Give the precautions that must be taken in preparing samples of milk and cream for testing.

2. (a) Name the different steps in making a Babcock test of milk.

(b) Of Cream.

Note: Reasons for methods not required here.

EXERCISE V

MODIFYING TESTS

1. Test for fat by the Babcock method a sample of whole milk, skimmed milk and cream in the usual way.

2. Retest the skimmed milk and cream.

In retesting the skimmed milk use the same amount of acid as for whole milk (17.5 cc.) and centrifuge five, two and one minutes.

In retesting the cream do not add water to the cream before adding the acid.

3. Retest the cream.

In retesting the cream measure it with the pipette instead of weighing it.

Compare the results obtained by measuring and weighing the sample.

QUESTIONS

1. Which is heavier—cream containing a high percentage of fat or cream containing a low percentage and why?

2. By a diagram and written description explain how to read a Babcock fat test (a) of milk; (b) of cream.

3. Explain why the method differs for reading the two tests.

4. Describe how to make meniscus remover.

5. Why is cream weighed into the test bottle in place of measured in making the Babcock test?

6. What is the purpose of placing water in the cream test bottle before adding the acid?

7. What is "meniscus remover" and why is its use necessary?

8. How does the fat in skim milk compare with the fat in whole milk?

TESTING BUTTER FOR MOISTURE

Practically the only volatile substance in butter is the water. It may be all driven off by heating to 100° C. for a sufficient length of time, care being taken not to overheat or char any of the other constituents. A number of moisture tests have been developed and most of them are carried out approximately on the principle of the Patrick butter moisture test, which was one of the earliest developed.

Operating the test: A representative sample of the butter is mixed until it is of a homogenous mass. Ten grams of the prepared butter are then weighed out in an aluminum cup. The cup is then heated over a flame. Prof. Ross in the Cornell Butter moisture test advises the use of an asbestos pad to be placed between the flame and the cup containing the butter. The cup should be shaken while heating by holding it with the hot pan lifter and giving it a rather vigorous circular motion. Each speck of casein has a white color until it loses its moisture; therefore, heating is continued until the last white particle has changed to a light brown color.

When the moisture is all driven off as indicated by the color of the casein, the cup is covered and allowed to cool to room temperature in a clean dry place. When cooled it is again weighed and the loss in weight divided by the weight of butter placed in the cup. The quotient multiplied by 100 gives the percentage of moisture in the butter.

EXERCISE VI

BABCOCK TEST, BUTTER MOISTURE TEST AND COMPOSITE SAMPLES

1. Test for fat by the Babcock method a sample of buttermilk, cheddar cheese and whey.
2. Test for fat each of the five samples of milk furnished. Place in a lightning top sample jar an aliquot sample from each of the five samples just tested. Add a preservative and hold for future testing. Record the number of cc. in each bottle of milk sampled.
3. Test a sample of butter for moisture by the Cornell method.

QUESTIONS

1. Describe the condition of the water in butter (a) when the sample is taken (b) after properly preparing the sample for making a moisture test.
2. How may we know when all of the moisture has been driven from a butter sample and what causes this change?
3. Why is it necessary to use different amounts of sulphuric acid in testing different dairy products for fat?
4. How does whole milk cheese, part skimmed cheese and full skimmed cheese differ in composition?
5. Give the only advantage, in taking milk samples, that a milk sampling tube has over a small dipper.

THE SPECIFIC GRAVITY OF MILK AND THE USE OF THE
LACTOMETER

The specific gravity of a substance may be defined as the weight of unit volume of that substance as compared to the unit volume of some other substance which is taken as a standard. Water is taken as the standard for all liquids and it has a specific gravity of one. Milk varies in specific gravity from 1.029 to 1.035, the average specific gravity being 1.032.

The instrument used for determining the specific gravity of liquids is called a hydrometer, and there are many kinds of specialized hydrometers, one of which is called a lactometer. The lactometer is an instrument used to determine the density of milk. There are two general types of lactometers in use in this country: the Quevenne and the New York State Board of Health or ordinary lactometer. The latter is commonly called the B. of H. lactometer.

A Lactometer consists of a hollow glass cylinder drawn to a long narrow stem at one end and a weighted bulb at the other. On the stem is a scale which gives the density of the milk. The weight consists of shot or mercury. The weight makes the instrument take an upright position in the liquid and also locates the position of the hydrometer scale in the stem. The higher priced instruments contain a thermometer. The thermometer bulb containing the mercury is annealed in the instrument over the hydrometer bulb and the thermometer stem passes up thru the body and stem of the lactometer. The thermometer scale appears on the opposite side of the stem from the hydrometer scale or over it.

The Quevenne lactometer is an instrument graduated from 15°—40° corresponding to specific gravities of 1.015—1.040. The chief advantage of the Quevenne lactometer is that it reads the specific gravity of milk directly by placing the figures 1.0 before the lactometer reading. (Example: Lactometer reading—32. The specific gravity—1.032.)

The Board of Health lactometer is the same as the Quevenne lactometer with the exception of the lactometer scale. If the Quevenne scale were put in a suitable B. of H. lactometer you would have a Quevenne lactometer. The B. of H. scale extends from 0° to 120° and there are sixty divisions each equalling two

on the scale. A reading of 100 on the B. of H. scale corresponds to a reading of 29 on the Quevenne scale.

One degree on the Quevenne equals 3.44 on the B. of H. ($100 \div 29 = 3.44$.) To convert from B. of H. reading to Quevenne reading you multiply the B. of H. reading by .29 and to convert from Quevenne reading to B. of H. reading you divide by .29.

Average quality milk reads 32 on the Quevenne scale but pure milk readings vary between 29 and 35. Average quality milk reads 108 to 110 on the B. of H. scale but pure milk reading may vary between 100 and 115.

Temperature corrections for the lactometer: It is a well known fact that volume and density are affected by temperature. As the temperature rises the volume increases and the density decreases and as the temperature falls the changes occur in the opposite direction. A 10° temperature change equals 1° on the Quevenne lactometer scale and 3° on the B. of H. lactometer scale, or 1° temperature change equals .1 of a lactometer degree on the Quevenne scale and .3 of a lactometer degree on the B. of H. scale. The lactometer reading should be taken at a temperature near 60° F. as the temperature correction factor varies when too far away from this figure. If the temperature of the milk is below 60° F. subtract the correction factor and if the temperature is above 60° F. add the correction factor.

FORMULAS FOR CALCULATING SOLIDS NOT FAT

When the Quevenne lactometer reading and the per cent of fat in a sample of milk are known the per cent of solids not fat may be calculated by formulas. A great many formulas have been developed but the following formulas developed by Babcock are most generally used.

$$1. \frac{L + .7F}{3.8} = \text{S. N. F.}$$

$$2. \frac{L}{4} + .2F + .14 = \text{S. N. F.}$$

$$3. \frac{L}{4} + .2F = \text{S. N. F.}$$

L = Lactometer reading (Quevenne)

F = The per cent of fat.

Formula 1 gives the best results when used on rich milk.

Formula 2 is used with average milk.

Formula 3 is used with milk poor in fat.

Another formula developed by one of the authors is as follows:

$$\frac{L + F}{4}$$

This formula gives good results with average quality milk and milk rich in fat. It gives results a little too high for milk poor in fat.

Another formula developed by one of the authors where the B. of H. lactometer reading is used, is as follows:

$$\frac{1}{10}L - 3 + \frac{F}{4} = \text{S. N. F.}$$

L = The B. of H. lactometer reading.

F = The per cent of fat.

This formula gives good results with average milk and milk rich in fat but a little too high for milk poor in fat.

CALCULATING MILK ADULTERATIONS FROM THE LACTOMETER READING AND THE PERCENT OF FAT IN THE SAMPLE.

Example—A sample of normal milk had a lactometer reading of 32 @ 64° F. and a fat content of 4%. After being adulterated both by watering and skimming it showed a lactometer reading of 25 @ 50° F. and a fat content of 2.8%. Figure out the per cent of fat removed by skimming and the per cent of fat removed by watering.

Use the formula $\frac{L + F}{4}$

Correcting for temperature: 32 @ 64° F = 32.4 @ 60° F.

$$\frac{32.4 + 4}{4} = 9.1\% \text{ S. N. F. in the normal milk.}$$

The adulterated milk had a lactometer reading of 25 @ 50° F. and correcting for temperature it would be 24 @ 60° F.

$$\frac{24 + 2.8}{4} = 6.7\% \text{ S. N. F. in the adulterated milk.}$$

Since there were 9.1 parts of S. N. F. before adulteration and

6.7 parts of S. N. F. after adulteration 2.4 parts were removed by adulteration.

$$9.1 - 6.7 = 2.4$$

$2.4 \div 9.1 = .2417 \times 100 = 24.17\%$ of the S. N. F. removed by watering.

Before adulteration the sample had 4 parts of fat and after adulteration 2.8 parts of fat; 1.2 parts of fat were removed.

$$4 - 2.8 = 1.2$$

$$1.2 \div 4 = .3 \times 100 = 30\%$$

Therefore 30% of the total fat has been removed. When water is added to milk all of the solids are reduced in the same proportion.

It was shown that 24.17% of the solids not fat were removed by watering, therefore 24.17 per cent of the fat were removed by watering according to the above rule.

The total fat loss was 30%. Therefore the difference between 30% and 24.17 = 5.83% which was removed by skimming.

EXERCISE VII

EFFECT OF TEMPERATURE AND DIFFERENT AMOUNTS OF ACID
AND USE OF QUEVENNE LACTOMETER

1. Test in duplicate by the Babcock method a sample of whole milk as follows:

- (a) Use ordinary amount of acid.
- (b) Use one-half the usual amount of acid.
- (c) Fill the bottle to the base of the neck with acid.
- (d) Use the regular amount of acid, but warm the acid and milk to 100° F. (before mixing)

Add the acid slowly to the sample.

Observe and record all results carefully.

2. Test the sample preserved from the last exercise. Allowing each cc. of milk in each quantity of milk sampled to represent one pound of milk, calculate the theoretical per cent of fat in the preserved sample.

Compare results with the actual test of the composite sample.

3. Take the Quevenne reading of a sample of milk at 60° F. Warm the milk up to 100° F., recording the lactometer reading at each 10° rise in temperature. Cool the milk as low as possible, recording the lactometer reading at each 10° drop in temperature.

Note. Remove the lactometer and mix the milk thoroughly before each reading.

Compare the readings with those obtained with the lactometer by applying the correction factor for temperature.

Make a drawing of the Quevenne lactometer, labelling each part and state the purpose of each part.

QUESTIONS

1. Why is the Babcock test not reliable for determining the percentage of fat in butter?

2. Why and how does a change in the temperature of the milk affect the lactometer reading?

3. Give the precautions that must be taken in holding composite samples for testing.

4. Why should a composite sample be made up of aliquot portions of each mass of milk sampled?

5. Define Specific Gravity.

6. Explain why and how varying the amount and the temperature of the acid used affects the fat column in the completed test.

7. Give the precautions that must be taken to insure proper action by the acid in testing dairy products.

8. Was there any indication that the preservative in the composite sample affected in any way the appearance or reading of the test?

EXERCISE VIII

COMPOSITION OF MILK AND TEST FOR BOILED MILK

1. Test a sample of whole milk and skimmed milk for fat by the Babcock method.

Take the Quevenne and B. of H. lactometer readings of the milk and skim-milk. Convert the B. of H. lactometer reading to the Quevenne reading and compare the result with the actual reading obtained with the Quevenne lactometer.

Compute the S. N. F. in the whole milk by using three different formulae and compare results obtained.

2. Measure out in duplicate into two cream test bottles a sample of skimmed milk as for the Babcock test. Before adding the sulphuric acid dip a stirring rod into the formaldehyde and rinse it off in one of the samples. Then add to both samples the ferric chloride and the sulphuric acid and note the difference in color due to formaldehyde.

3. Test for formaldehyde any four of the samples furnished. Report the results by number.

4. Place into each of two whole milk bottles a sample of boiled milk. Number the bottles one and two. Into each of two whole milk bottles place a sample of raw milk. Number the bottles one-A and two-A.

A. Test for boiling bottle number one of the boiled milk and bottle number one-A of the raw milk. Use the calcium peroxide and the paraphenylene diamine-hydrochloride.

B. Test for boiling, bottle number two of the boiled milk and bottle number two-A of the raw milk. Use the calcium peroxide, the potassium iodide solution and the starch solution.

QUESTIONS

1. Can pasteurized milk be distinguished from raw or boiled milk by the boiled milk test?

2. Upon what principle does the boiled milk test depend?

3. Why does sulphuric acid alone sometimes give the formaldehyde test?

4. Is it legal to use formaldehyde as a milk preservative? Give its relative merits as a milk preservative.

EXERCISE IX

BABCOCK TEST AND CALCULATING ADULTERATION

1. Test for fat by the Babcock method a sample of whole milk, cream and a sample of skimmed milk.

Take the Quevenne lactometer reading of both the whole milk and the skimmed milk.

2. Place in the lactometer cylinder 100 cc. of the whole milk and 75 cc. of the skimmed milk. Mix thoroughly and again take a lactometer reading and make a fat test of the mixture. Then add to the mixture of whole milk and skimmed milk 25 cc. of water. Mix well and again take a lactometer reading and make a fat test. Compute the percentage of fat removed by skimming and the percentage of fat removed by watering and the total fat loss.

3. (a) To 200 cc. of the skimmed milk used in experiment one add 25 cc. of the cream used in experiment one. Mix thoroughly and take a lactometer reading. Make a fat test and calculate the effect on both the Board of Health and Quevenne lactometer reading of one per cent increase of the fat.

(b) Take a lactometer reading of a sample of water. To 200 cc. of the water add 100 cc. of the skimmed milk. Again take a lactometer reading of the mixture and calculate the effect of one per cent of solids not fat on the lactometer reading. Use both the Quevenne and the Board of Health lactometers.

QUESTIONS

1. Why does whole milk and skimmed milk differ in specific gravity?

2. What is the difference in effect of one per cent of fat and one per cent of solid not fat on (a) the B. of H. lactometer reading; (b) on Quevenne lactometer reading; (c) on the specific gravity?

3. What is the difference in effect on the physical properties and composition of whole milk when water is added and when skimmed milk is added?

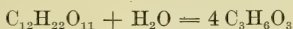
4. Give the composition of the milk from four of the principal breeds of dairy cattle.

REASONS WHY MILK GIVES AN ACID REACTION

1. Milk contains substances that cause that which is called the **apparent acidity**. These substances are the acid phosphates, the casein which will take up some alkali, and the carbon dioxide that may be in solution in the milk.

2. The **real acidity** is due to the lactic acid, or to the casein freed by the acid uniting with the calcium in the milk.

The presence of real acidity or lactic acid in the milk is due to the action of lactic acid organisms (or germs) on the milk sugar.



There are two theories in regard to the actual formation of the acid.

1. That the germs produce an enzyme which acts upon the milk sugar and produces an acid.

2. That the germs produce the acid by acting directly on the sugar. This last theory is the one generally accepted. The apparent acidity usually does not go above .18 per cent, but may go to .25% calculated as lactic acid. .05 to .10% of real acidity in milk can be detected by the sense of smell. .10% to .15% of real acidity in milk can be detected by taste. .58% of acid will produce coagulation at ordinary temperatures. When .8% of lactic acid has developed in milk the germs cease to produce more.

In the acid test, the acid is measured by adding two or three drops of an indicator (phenolphthalien) to a known weight of the milk and then running in from a graduated burette, an alkali solution of known strength until the milk turns pink. When the solution turns pink we know that all the acid has been neutralized and the percentage of acid may be calculated. Equal volumes of acid and alkali solutions of the same strength will neutralize each other.

In preparing solutions for determining the percentage of acid or alkali in other solutions, there must be a standard of strength to work by and this standard is the normal solution.

A normal solution contains in one liter one gram of replaceable hydrogen or its chemical equivalent. Therefore one cc. of a normal solution of an acid will be neutralized by an equal volume of a normal solution of an alkali because they contain amounts of the reagents that are chemically equal. And one cc. of a normal

solution would neutralize .09 grams of lactic acid as that is the amount which one cc. of a normal solution of lactic acid contains.

Since more accurate work can be done with weak solutions, it is customary to use those of tenth normal strength, written N/10. One cc. of a N/10 solution of an alkali will neutralize .009 grs. of lactic acid.

To determine the per cent of acid in the milk, multiply the number of cc. of N/10 alkali used to neutralize a known weight of the milk by .009 and divide by the weight of milk taken. If the milk was measured out for titration, it should be changed to grams by multiplying the number of cc. used by the specific gravity.

THE ACIDITY OF MILK

When the chemical properties of substances are studied it is found that a number have opposite characteristics and that many substances can be placed in one or the other of three classes. These classes are acids, alkalies and salts. The acids and bases when brought together always tend to neutralize each other forming new substances that are called salts. The salts do not possess the characteristic properties of either the acids or the alkalies. It is often necessary to determine whether substances have acid or alkali properties and this is done by using reagents that are called indicators. There are many kinds, but the indicator generally used in acid tests of milk is named phenolphthalein. It is colorless in acid solutions and purple or pink in alkaline solutions. It is important to know the acidity of the milk for the following reasons:

1. In the ripening of cream, unless sweet butter is to be manufactured.
2. In the making of cheese: when to add the rennet, when to draw off the whey, when to mill the curd, etc.
3. Sometimes of value in market milk work in determining whether a certain mass of milk is fit to send to the market.
4. When condensing milk it enables the man on the receiving platform to select the milk that is not too sour and reject milk that has developed more than .2% acid.
5. In making sour milk beverages.
6. Manufacturing of casein.

ALKALINE TABLET SOLUTION

Professor Farrington of the University of Wisconsin devised alkaline tablets to be used in determining the percentage of acid in milk. These tablets are made up so that each will neutralize .03492 grams of lactic acid. When five tablets are dissolved in 97 cc. of water the solution is of such strength that one cc. of it will neutralize .01 of one per cent of lactic acid when 18 grs. (1 pipette full) of milk are taken. The solution should not be allowed to stand uncorked. The indicator is added to the tablets when they are manufactured, therefore it enters the milk with the alkali tablet solution and no more indicator (phenolphthalein) need be added. The following example shows how these tablets are used.

Suppose that it required 15 cc. of an alkali tablet solution to neutralize the acid in 18 grs. of milk. The tablet solution was made by dissolving 7 alkali tablets in 100 cc. of water. What is the per cent of acid in the milk?

One tablet will neutralize .03492 grs. of lactic acid.

$.03492 \times 7 = .24444$ grams of lactic acid that seven tablets will neutralize,

Since the seven tablets were dissolved in 100 cc. of water, the entire 100 cc. of the solution would neutralize .24444 grams of lactic acid. Then $.24444 \div 100 = .0024444$ the grams of lactic acid that one cc. of the solution will neutralize.

$.0024444 \times 15$ (cc. used) = .036666 grams of acid neutralized.

$.036666 \div 18 = .002039 \times 100 = .2039\%$

EXERCISE X

BABCOCK TEST, ACID TEST AND DENSITY

1. Test the skimmed milk for acid using tenth-normal alkali solution and a Farrington alkali tablet solution.

2. Test for acid 17.6 cc. of tap water (1 pipette full). Add to a pipette full of the water 5 cc. of starter or buttermilk. Again test for acid using the tenth-normal alkali solution.

3. Test for fat by the Babcock method a sample of whole milk and a sample of butter.

4. Take both the Quevenne and the Board of Health lactometer readings of a sample of whole milk and make the necessary temperature corrections for the lactometer readings.

Add 50 cc. of water to 200 cc. of the milk and take the lactometer reading. Use both lactometers. Calculate the percentage of water that would cause the lowering of the lactometer reading one degree.

Add a gram of salt to the solution and again take both lactometer readings. Calculate the percentage of salt that would cause the raising of the lactometer reading one degree. Use both lactometers.

5. Determine the acidity of a sample of fresh milk using the tenth-normal alkali solution. Divide the milk into two portions. Calculate the amount of buttermilk that must be added to one portion of the fresh milk to increase the acidity .02 per cent.

Add the required amount of buttermilk to this portion of the fresh milk. Make a determination of the increased acidity in the mixture by titrating with tenth-normal alkali.

6. Place 2 cc. of each sample into each of two test tubes and have both at a temperature of from 60°—70° F. Add to each, 2 cc. of a 68% alcohol solution, shake with a circular motion to mix thoroughly. Then shake the tube to splash some of the mixture against the wall of the tube an inch or more above the surface of the liquid.

The presence of lactic acid in the milk will be shown by small flakes of casein deposited on the wall of the test tube above the surface of the milk.

QUESTIONS

1. Why was there a demand for an alkali tablet solution in place of a tenth-normal alkali solution?
2. What is "starter" and for what is it used?
3. Why was there a demand for the alcohol test in determining milk quality? Upon what principle does it depend?
4. Explain the differences between a normal solution, a standard solution and a saturated solution.

CHEESE MOISTURE TEST

Laws enacted recently by various States limiting the amount of water permissible in cheddar cheese have created a demand for a practical cheese moisture test. The ordinary butter moisture test, in which a metal cup is heated over a flame, cannot be used for determining the percentage of water in cheese because the high temperature developed in operating that test drives off from the cheese other substances with the water. Also, particles of cheese are lost by spattering when the cheese is heated with any degree of rapidity in the shallow butter-moisture cups.

To overcome these difficulties the new method here described was developed by one of the authors for the purpose of determining the percentage of moisture in cheese. The apparatus used in the new test consists of:

- 1 double-walled copper drying cup
- 1 centigrade thermometer registering to 200°
- 1 alcohol lamp
- 1 tripod
- 1 special flask
- 1 scales sensitive to 0.01 gram
- 1 set of weights, 0.01 to 100 grams.

Operating the test: In operating the test the alcohol lamp is first lighted, so that the oil bath may be warming while the test sample is under preparation. A representative sample of the cheese, which may be taken with a cheese trier and held in a glass-stoppered sample jar, is then cut into particles about the size of kernels of wheat without removing it from the jar. This may be done with an ordinary table knife that has had the end squared and sharpened. The clean dry flask is then accurately balanced on the scales and a 5-gram weight is placed in the opposite scale pan. Particles of cheese from the prepared sample are put into the flask until the scales comes to an exact balance. Great care should be taken to avoid loss of moisture from the cheese during the preparation of the sample.

With the thermometer in the oil bath registering a temperature between 140° and 145° C. (or between 284° and 293° F.), the flask is placed in the cup of the oil bath and the flat, disk-shaped cover is adjusted over the apparatus. The flask should remain in the bath for fifty minutes, the temperature being kept between 140° and 145° C. all the time. The flask is then removed, covered, and

allowed to cool to room temperature in a dry place. It is then weighed, and the quotient obtained by dividing the loss in weight by the original weight, multiplied by 100 gives the percentage of water in the cheese. The following shows the method of computation:

Problem: Five grams of cheese was heated until the water contained in it was evaporated. The remaining substance weighed 3.15 grams. What percentage of water did the cheese contain?

Answer: $5.00 - 3.15 = 1.85$

$$1.85 \div 5 = 0.37$$

$$0.37 \times 100 = 37 \text{ (percentage of water in cheese)}$$

A butter moisture scales with an extra 5-gram weight may be used for weighing out the 5 grams of cheese. If the scales indicates the amount of moisture in 10 grams of butter by percentage graduations on its beam or by percentage weights, then it will be necessary to multiply by two the percentage indicated by such scales or percentage weights when only 5 grams of cheese is used.

EXERCISE XI

CHEESE MOISTURE TEST, BABCOCK TEST, ACID TEST AND
LACTOMETER

1. Test a sample of cheese for moisture by the Cornell method.
2. Test for fat by the Babcock method a sample of cheese, whole milk and a sample of cream.
3. Test for acidity a sample of milk and a sample of cheese.
4. Take the lactometer reading of the whole milk and compute the total solids using all three formulae.

QUESTIONS

Why cannot cheese be tested for moisture in the same way as butter is tested for moisture?

To what is the high acid content of cheese due?

SALT IN BUTTER

The percentage of salt in butter varies to a greater extent than any other constituent. Salt is added to butter to assist in removing the butter milk to improve the keeping quality and give an acceptable flavor. Usually more than one per cent and less than four per cent of salt is left in the butter after the working process is completed. The amount of salt left in the butter may depend upon the demand of the trade supplied or upon the methods and skill of the butter maker.

The best way to learn how to control the per cent of salt is to make salt tests of the finished product from day to day and note the effect of the various conditions connected with the churning and the working process upon the per cent of salt retained. The salt should always be in solution and it is held in solution by the water that is in the butter. The lower the water content of the butter the lower would be the per cent of salt that would be held in solution. Thus a sample of butter that contained 14% of moisture and 3% of salt would not be so liable to have salt crystals deposited as would a sample that contained 3% of salt and only 10% of moisture. The difference in taste of butter containing 2% of salt and butter containing 3% of salt is marked, but the taste will distinguish very little difference between butter containing 5% of salt and another sample containing 8% of salt. This is due to the fact that the final taste on the tongue is due to pure salt in each case.

TESTING BUTTER FOR SALT

One of the authors developed the following test in 1908 to supply the demand of butter makers for a simple, accurate and practical method to determine the per cent of salt in their product. Apparatus.

One ten cc. burette graduated to tenths of a cc.

Babcock milk pipette.

One white cup.

One pint bottle marked to show the line at the upper surface of the liquid when the bottle contains 300 cc.

Reagents.

Standard tenth normal silver nitrate solution (AgNO_3)

Ten per cent potassium chromate solution. (K_2CrO_4)

The test is performed as follows: A homogeneous sample of the butter is prepared in the same way as for the butter fat or butter moisture test. Weigh ten grams of the prepared sample into a suitable dish. Or if a moisture test was made on ten grams of butter, that remaining in the cup when it is finally weighed may be used. Wash the butter from the cup into the bottle marked at the 300 c.c. point. Make certain that no salt remains in the cup and use water sufficiently hot to readily melt the butter. Usually about 200 cc. is used for this purpose. Next add enough hot water to bring the surface of the water on a level with the line at the 300 cc. mark. The melted butter fat floating on the surface of the water should then be above the 300 cc. line. Place the stopper in and shake the bottle vigorously for about a minute. That will enable the water to dissolve all of the salt and wash it out of the fat. Let the bottle remain quiet for about five minutes until most of the fat has risen to the surface. Then draw a Babcock pipette full to the mark (17.6 cc.) of the water portion and place it in a white cup. Add three or four drops of the potassium chromate solution, stir, and run in the standard silver nitrate solution from the burette, with constant stirring until the yellowish solution in the cup takes on a permanent light brownish tinge of color. Then read on the burette scale the number of cc. of the standard tenth normal silver nitrate solution used. Each cc. of the tenth normal silver nitrate solution used equals one per cent of salt in the butter. In adding the silver nitrate solution care should be taken to not run in any more than enough to cause the first permanent brownish color to appear. A deep brown color indicates that a little more of the silver nitrate solution was run in than was necessary.

EXERCISE XII

BABCOCK TEST, USE OF HAND MACHINE, ACID TEST, BUTTER
MOISTURE AND SALT TEST

1. Test for fat by the Babcock method in the steam machine a sample of whole milk, skimmed milk and cream.

Retest the whole milk in the hand machine and compare the results with those obtained in the steam machine.

2. Test for acid a sample of whole milk, cream and skimmed milk using both the tenth-normal alkali solution and a Farrington alkali tablet solution.

3. Test a sample of butter for moisture and salt using the Cornell method in each test.

1. What special precaution must be observed in using a hand machine for determining the fat content of milk?

2. Prove by a numerical problem that the Cornell Salt test for salt in butter is correct.

EXERCISE XIII

MICROSCOPICAL APPEARANCE OF MILK, USE OF RENNET, SALT TEST, BABCOCK TEST

1. Examine under the high power microscope a sample of whole milk, skimmed milk and cream.

Make drawings of each field.

2. Take 18 grams of milk at 50°F and add four drops of rennet, shake thoroughly and let stand.

Note the length of time it takes the milk to curdle.

Repeat at temperatures of 80°F, 100°F, 150°F.

3. To 100 cc. of water add 1cc. of sulphuric acid. Add one cc. of this solution to 18 grs. of milk and add 4 drops of rennet at 50°F, 80°F, 100°F and 150°F. Note the time it takes the milk to coagulate. Compare the length of time with that required in No. 2.

4. Test for fat by the Babcock method a sample of evaporated milk.

5. Test for salt a sample of butter.

QUESTIONS

Give the reasons for all the differences in appearances between the field of cream, whole milk and skim milk examined under the microscope.

What is rennet and how is it prepared?

If the total solids of milk were reduced 5% by the addition of water how would it effect the percentages of each other constituent in the milk?

What two agencies hasten the action of rennet on milk?

How does pepsin compare with rennet in coagulating milk in cheese making?

COW TESTING ASSOCIATION RECORDS

One of the purposes of a cow testing association is to obtain the yearly production records, for milk and fat, of each cow in the association. In the usual procedure about 25 producers form an association and employ a man for a year to weigh and test for fat, once each month, two successive milkings from each cow in each herd in the association. The monthly record for each cow is obtained by multiplying the production record for the day she is tested by the number of days in that month. From this data the yearly records are calculated.

EXERCISE XIV

BABCOCK TEST, COW TESTING ASSOCIATION EXPERIMENT

1. Test for fat by the modified Babcock method a sample of ice cream and a sample of powdered milk.

2. Cow testing association experiment.

Go to a nearby dairy at milking time and obtain samples of milk from five cows on two successive milkings. The samples should be proportionate to the yield. Then the two from the same cow may be mixed and tested. Enough milk should be taken from each of the two messes so that when mixed together the amount will be large enough to permit the lactometer reading to be taken—approximately 200 cc.

Record the weight of milk at each milking. Test the samples for fat by the Babcock method and take the lactometer reading.

Then calculate the pounds of milk, pounds of fat and pounds of solids not fat each cow would produce in 30 days.

3. Save, without preserving, a sample of milk for the next exercise.

QUESTIONS

What is a cow testing association?

How is it operated?

How do the tests of the milk made by the cow testing association compare with the test of that milk when it is sold at the factory?

What are the duties of the tester who does cow testing association work?

Why cannot ice cream be tested for fat in the same way as ordinary cream?

Why does the modified Babcock test for fat in ice cream give better results than the regular Babcock method as applied to testing ice cream?

Briefly describe two methods of manufacturing milk powder and give difference in composition of the product by different methods.

RECORD SHEET

Herd No.

Owner, Mr.

Address

Date _____

[illegible]

EXERCISE XV

TESTING SOUR MILK, EFFECT OF TEMPERATURE, USE OF
DIFFERENT ACIDS

1. Test for fat the sample of coagulated milk soured from previous exercise, first by measuring out the sample after thorough mixing; secondly by adding 1 gram of powdered sodium hydrate to dissolve casein, then testing as before.

3. Effect of temperature on volume. Measure out at room temperature (about 70°F.) a sample of milk for Babcock test.

Cool the milk to as near freezing as possible and measure out a Babcock test. Heat the milk to 180°F. and measure out sample for Babcock test. Test the samples and compare the results.

5. Place 18 grams of milk into each of 5 Babcock milk test bottles—To No. 1. add 17.5 cc. of hot water.

To No. 2. add 17.5 cc. of hydrochloric acid.

To No. 3. add 17.5 cc. of glacial acetic acid.

To No. 4. add 17.5 cc. of nitric acid.

To No. 5. add 17.5 cc. of sulphuric acid.

Proceed to complete the test as in the regular Babcock method.

QUESTIONS

1. What is the maximum limit of error allowed for a cream testing balance?

2. When milk is heated why does a skin form on its surface?

3. What effect do alkalis have upon the constituents of milk?

4. How do the different acids, used in experiment 5 compare in their action toward milk and milk fat?

5. Why does the temperature of the contents of a Babcock test bottle vary in different parts of the bottle when the test is completed?

EXERCISES

PART II

EXERCISE XVI

VARIATIONS IN COMPOSITION OF MILK, ACID TEST,
ADULTERATION.

1. Obtain a sample of fore milk, middle milk and strippings and also a sample of the entire milking. All these samples should be taken from the milk of one cow and at one milking time.

Make a fat test and lactometer reading of each sample.

Estimate the percentage of solids not fat and total solids in each sample.

2. Test a sample of milk for acid using both the tenth-normal alkali solution, the Farrington alkali tablet solution and the alcohol test.

3.(a) Test for fat by the Babcock method a sample of whole milk and a sample of skimmed milk and take a lactometer reading of each.

(b) To 300 cc. of the milk just tested add 100 cc. of the skimmed milk. Make a fat test of the mixture and take a lactometer reading.

(c) Then add to the mixture of whole milk and skimmed milk 100 cc. of water. Make a fat test of the mixture and take the lactometer reading.

From the data secured in Experiment 3-a what would be the theoretical composition of the milk in Experiment 3-(b) and 3-(c)?

4. From the data secured in experiment one and three determine (a) The percentage of fat removed by watering; (b) the percentage of fat removed by skimming.

QUESTIONS

Why do we have two necks on skimmilk test bottles?

Why does milk turn sour and the casein coagulate?

Why were so many different tests for fat in milk developed between 1888 and 1890?

Name the tests brought out during this period.

What is meant by the term "colostrum"? Give its average composition and specific gravity.

Why does milk from different parts of the udder vary in composition?

What are the most common causes of the variation of the fat content of milk?

What is the reason for the variation of the fat content of milk as drawn from the udder during a single milking?

EXERCISE XVII

COMPARING DIFFERENT FAT TESTS, EFFECT OF TEMPERATURE
AND TESTING MILK POWDER

1. (a) Using Professor Feser's Lactoscope, determine the per cent of fat in a sample of milk and compare with the Babcock method.

(b) Using Heren's Pioscope, compare the samples furnished in respect to per cent of fat. Check your results by the Babcock method. Draw conclusions.

2. Test a sample of cream with a 9 gram, 6 inch cream bottle and with a 9 gram, 9 inch cream bottle. Place the completed test in a water bath and raise the temperature of the water from 100° F. to 180° F. Take readings at every 10 degrees rise in temperature. Do not use meniscus remover in this experiment. For comparison read from bottom of fat column to bottom of top meniscus. Draw conclusions as to effect of temperature on volume of the fat.

3. Weigh into a milk test bottle 2.5 grams of milk powder. Add 15.5 cc. of warm water, dissolve by shaking, cool and test for fat as for whole milk. Calculate the per cent of fat.

QUESTIONS

By whom was the Pioscope invented?

Who invented the Lactoscope?

Upon what physical properties of the milk are these tests based?

What was the cream gauge method of determining the per cent of fat in milk? How was the per cent of fat determined by this test?

If the graduated portion of a 9 gr. cream test bottle was full of butter fat, what would be the weight of the fat?

Give a brief history of the development of milk fat tests.

If seven grams of 30% cream were placed in a 9 gram cream test bottle what would be the volume of fat in cc. in the neck of the bottle and what would the percentage reading on the scale be when the test is completed?

EXERCISE XVIII

THE BABCOCK AND SHAW BUTTER FAT TESTS

1. Test butter for per cent of fat by the Babcock method using different kinds of butter bottles and cream test bottles.
2. Test the butter by the Shaw method and compare the results with the Babcock method where different kinds of bottles were used.

The Shaw Method: Clean, dry and weigh the special separatory funnels. Weigh into a 100 cc. glass beaker, after balancing it on a scales, 20 grams of the properly mixed sample. Warm the beaker or add a little hot water to melt the butter. Pour it into the separatory funnels. By repeated washings with a fine stream of hot water using not more than a teaspoonful each time, rinse the beaker free from fat until the funnel is full to within one-quarter of an inch of the shoulder. Using the special socket centrifuge the funnels. The socket **must** be placed in the centrifuge with the open side facing the direction in which the disc revolves. The centrifuge must be warm. Whirl one minute at speed used for milk. Remove the funnels and draw off the water (using care not to permit the cocks to stick) until the casein is within one-eighth of an inch of the stopcock. Then add 9 cc. of cold water and 11 cc. of Babcock sulphuric acid after mixing them together in a beaker. Mix to dissolve the curd, centrifuge as before. Draw off the acid solution until the fat is within one-fourth of an inch of the stopcock, and repeat the addition of the acid, once more. After drawing off the second acid solution, centrifuge another minute and allow the fat to come down through the stopcock to the end of the capillary stem. Carefully dry the separatory funnels on the outside with a clean towel and weigh. The weight thus obtained minus the weight of the funnels equals the weight of butter fat in 20 grams of the butter. One addition of the acid may suffice, but usually two additions are necessary. If the weight of the clean dry funnels is once secured, it will not be necessary to have them dry on the inside before using. If any glass is chipped off they should be reweighed.

QUESTIONS

Why will variations in the specific gravity of the butter fat make the Babcock test less accurate than the Shaw test for fat in butter?

Why may not the regular cream test bottle be used for testing butter for fat?

Name four sources of error that are difficult to avoid in making the Shaw Butter fat test.

EXERCISE XIX

COMPARISON OF THE BABCOCK AND ADAMS TESTS FOR FAT IN MILK

1. Test in duplicate a sample of whole milk and skimmed milk for per cent of butter-fat by the Babcock method and compare the results with those obtained by the following chemical method.

2. Adams Methods: For this method, a strip of fat-free filter paper $2\frac{1}{2}$ inches wide and 22 inches long is rolled into a coil and held in place by a wire about 8 inches in length, wound once around the coil and projecting one end of the wire for use in hanging the coil up for drying. About 5 grams of milk is measured into a small beaker with a pipette, and the weight of the beaker and milk taken. One end of the coil is then introduced into the beaker in such a manner that as much as possible of the milk is absorbed by the paper. By then weighing the beaker, the amount of milk absorbed by the paper coil is determined by the difference, and the paper coil hung up and dried, first in the air, and then in the water oven at a temperature not exceeding 100° C. The coil containing the dried residue is then transferred to the Soxhlet extraction apparatus and subjected to continuous extraction with **anhydrous ether** for at least two hours, the receiving flask being first accurately weighed. The tared flask with its contents is freed from all remaining ether first on the water bath and finally in the air oven. The flask is then cooled in the dessicator and weighed; the increase in weight represents the amount of fat in the milk absorbed by the paper coil. Two hours is usually sufficient for the extraction of the fat, when the conditions are such that the ether siphons over from the extraction tube ten times per hour.

Tabulate the results of this experiment.

Make a drawing of the Soxhlet fat extraction apparatus as set up for the Adams method.

3. Sediment Test: Determine the amount of sediment in the different grades of milk by means of a Wizard sediment tester. Dry the different sediment pads on a clean sheet of paper that is to be handed in with report.

QUESTIONS

In the Adams test for fat in milk why must the coil containing the milk be dried before extracting with ether.

How do the Adams, Mojonier, and Babcock methods agree in determining the fat content of skimmed milk.

Does the prolonged heating of the fat in the water oven when driving off the last traces of ether affect the percentage of fat in any way? If so why?

What precautions are necessary in determining the amount of milk that is transferred to the paper coil in the Adams fat extraction method?

EXERCISE XX

COMPOSITION OF BUTTER BY THE GRAVIMETRIC AND KOHLMAN METHODS

1. The chemical gravimetric method for butter moisture: Prepare a sample of butter for the moisture test. Weigh out in tared dishes between 2 and 3 grams of the butter and evaporate at the temperature of boiling water for 10 hours. Cool in dessicator and weigh. The loss in weight divided by the weight of butter equals the per cent of water in the butter.

2. Test a 10 gram sample of the butter for moisture using a tall aluminum beaker on an asbestos pad over a gas flame for driving off the water and compare the results with those found by the chemical gravimetric method.

3. After cooling and weighing the beaker to determine loss of moisture in problem 2, fill it with petroleum ether and stir the contents with a glass rod. Cover and let stand about three minutes for solids to settle. Decant off the clear solution. Repeat the washing with the petroleum ether and decant off as before. Gently heat the beaker to remove last traces of petroleum ether. Heat carefully to avoid sputtering.

Reweigh the beaker and contents and determine the percentage of fat dissolved off.

Dissolve the contents of the beaker in 300 cc. of warm water and determine the percentage of salt in the butter by the Cornell Method.

QUESTIONS

1. What is the disadvantage to a creameryman of the chemical gravimetric method for determining moisture in butter?
2. Why is petroleum ether used in the Kolean method for estimating the fat content of butter?
3. What substances remain in the beaker after the moisture, fat and petroleum ether have been driven off?
4. How is the per cent of curd determined?

THE MOJONNIER TEST FOR FAT AND SOLIDS IN MILK AND ITS PRODUCTS

The Mojonnier tester and methods of analysis enables a chemist to determine the percentages of fat and solids in milk and all products made from milk, quickly and with a high degree of chemical accuracy. It modifies and adapts to factory conditions the Roese-Gottleib wet extraction method for fat determinations so that, in place of requiring several hours, tests may be completed in less than thirty minutes and the solids test may be run along with the fat test and completed in a short time. This enables the manufacturer of concentrated dairy products to learn the exact composition of his raw materials so quickly that he can control the composition of his finished product to meet the most exacting state, federal and quality standards.

The principal apparatus used in the Mojonnier method is the tester. It compactly combines electric hot plates, vacuum drying ovens, cooling ovens, centrifuge, power unit and chainomatic chemical balance. Special extraction flasks, evaporating dishes and pipettes are also provided.

EXERCISES XXI—XXII

THE MOJONNIER TEST FOR MILK FAT AND SOLIDS

1. Make a study of the parts and the mechanism of the Mojonnier tester.
2. Learn how to manipulate the Mojonnier fat and solids test and the reasons for using each reagent in the fat test.
3. Test a sample of whole milk for fat and solids by the Mojonnier method.
4. Take the lactometer reading of the whole milk tested under (3) and make a Babcock test of it. Calculate the percentage of total solids by applying formulas.
5. Compare the percentages of fat and the total solids obtained by the two methods.

EXERCISES XXIII—XXIV

TESTING AND STANDARDIZING BEFORE CONDENSING A BATCH
FOR THE MANUFACTURE OF EVAPORATED MILK *

1. Test the milk, skim-milk and cream on hand for fat and solids, using the Mojonnier method.
2. Calculate the number of grams of skim-milk or cream that must be added to 1000 grams of the milk to bring its percentage of fat and solids not fat to the desired ratio.
3. Add to 1000 grams of the milk the amount of skim-milk or cream required as found under (2) and test the mixture for fat and solids by the Mojonnier method.
4. After testing the mixture calculate its ratio of fat to solids not fat and compare the result obtained with the desired ratio.

* Note: Methods for solving standardizing problems are given in the book *The Technical Control of Milk Products* by Mojonnier and Troy 1922.

EXERCISES XXV—XXVI

TESTING AND STANDARDIZING BEFORE CONDENSING A BATCH
FOR THE MANUFACTURE OF SWEETENED CONDENSED MILK

1. Test the milk, skim-milk and cream on hand for fat and solids using the Mojonnier tester.

2. Calculate the number of grams of skim-milk or cream that must be added to 1000 grams of the milk to bring its percentage of fat and solids not fat to the desired ratio.

3. Make up the mixture as calculated under (2) and calculate the grams of sugar to add to obtain the desired composition.

4. Make up the mixture as calculated and test it for fat and solids using the Mojonnier method.

Calculate the ratio of fat to solids not fat obtained.

Calculate the ratio of fat to total solids obtained.

EXERCISES XXVII—XXVIII

TESTING AND STANDARDIZING ICE CREAM MIX

1. Make up a 1000 gram batch of ice cream mix so that the fat is about 0.3 per cent under, and milk solids not fat about 0.5 per cent over the desired standard. (See ¶3 for desired standard.)

2. Determine by using the Mojonnier method the exact percentages of fat and milk solids not fat in the mix. Also make these tests on the cream to be used in standardizing the mix.

3. Calculate the grams of cream, sugar and water that must be added to the mix in order to make it test 10% of fat, 11% of milk solids not fat and 13% of sugar.

4. Add the standardizing materials to the 1000 gram batch, mix thoroughly and test by the Mojonnier method for fat and solids.

Compare the percentages of fat and milk solids not fat obtained with those desired.

EXERCISES XXIX—XXX

TESTING AND STANDARDIZING ICE CREAM MIX (CONTINUED)

1. Make up a 1000 gram batch of ice cream mix so that the fat is about 0.5% over the percentage finally desired and the milk solids not fat about 0.3% under the percentage finally desired.

2. Determine by the Mojonnier method the exact percentages of fat and milk solids not fat in the mix. Also make these tests on the condensed skim-milk to be used in standardizing the mix.

3. Calculate the grams of condensed skim-milk, sugar and water that must be added to the mix in order to make it test 10% of fat, 11% of milk solids not fat and 13% of sugar.

4. After adding the necessary standardizing materials mix the batch thoroughly and make certain that the sugars are in solution. Again test the mix for its percentages of fat and milk solids not fat and compare the results with the composition desired.

EXERCISES XXXI—XXXII

TESTING AND STANDARDIZING ICE CREAM MIX (CONTINUED)

1. Make up a 1000 gram batch of ice cream mix so that the percentages of fat and milk solids not fat present are both about .5 per cent under that desired.
2. Test the batch for fat and milk solids not fat by the Mojonnier method. Also test the materials that are to be used in standardizing the batch.
3. Calculate the grams of each material to add to bring the fat and milk solids not fat up to the desired percentages.
4. Add the materials to the original mix and test the mix for fat and milk solids not fat by the Mojonnier method. Compare the percentages obtained with the percentages desired.

EXERCISES XXXIII—XXXIV

MAKING AND CHECKING STANDARD ACID AND ALKALI SOLUTIONS.

1. Make up an alkaline tablet solution by dissolving 26 Farrington alkaline tablets in small amount of distilled water and make the solution up to 100 cc. Determine the strength of alkaline solution by titrating with a standard HCl solution. What weight in grams of NaOH does each tablet contain? How many grams of lactic acid does each tablet neutralize according to your results?

2. Cork a clean dry test tube and weigh it accurately on a chemical balance. Working quickly, place in the weighed tube a stick of C. P. NaOH between two and three inches long. Cork the tube at once and reweigh. Determine the weight of caustic in the tube and dissolve it in distilled water at the rate of .416 grams for each 100 cc. of solution. Determine the strength of N/10 NaOH solution by titrating it against standard tenth normal hydrochloric acid and tenth normal oxalic acid solution. The standard HCl solution will be furnished. To prepare tenth normal oxalic acid ($C_2H_2O_4 + 2H_2O$) dissolve in distilled water at the rate of .63 grams for each 100 cc. of solution.

3. Test a sample of skimmed milk for per cent of acid by using each alkaline solution. Save some of the milk to be tested for acid at the next laboratory period.

4. Test a sample of vinegar for per cent of acid by using each alkaline solution.

Molecular formula for acetic acid = CH_3COOH

It will be necessary to determine the specific gravity of the vinegar. This may be done with a Quevenne lactometer.

5. Slake a few ounces of lime in a small amount of warm water. Add about 100 cc. of water to the slaked lime, and set aside until the next exercise.

6. Place 300 cc. of concentrated HCl in an evaporating dish. Add 200 cc. of water. Boil down to 200 cc. or $\frac{1}{2}$ of the original volume. The specific gravity then equals 1.10. It contains 20.2%

HCl. 18 grams of this solution diluted to 1000 cc. gives an N/10 solution of HCl. ($18.0 \times 20.2\% = 3.636$ grs.)

Using the above method make up an N/10 solution of HCl.

Note: Aliquot portions of the above amount may be used.

QUESTIONS

What is the advantage in using Farrington alkaline tablets in making an alkali solution?

Give the grams per cc. in tenth normal solutions of (a) three acid solutions; (b) three alkali solutions; (c) three salt solutions.

How much NaOH by weight does each tablet contain?

What is the legal requirement for vinegar in New York state?

What is the normality of a limewater solution?

If a N/10 KOH solution and a N/10 NaOH solution were mixed together, how would you use the resultant solution in determining the acidity in a sample of milk?

How does the specific gravity of vinegar vary from that of milk?

EXERCISES XXXV—XXXVI

MILK ANALYSIS, AND MODIFIED LEEFMAN-BEAM METHOD FOR FAT IN MILK AND CREAM.

1. Milk analysis. Take the Sp.Gr. of a sample of milk with Quevenne lactometer, and measure three cc. of the milk into a weighed silica dish. Evaporate to a constant weight at the temperature of boiling water (100° C.). Cool in a dessicator and weigh. Determine the per cent of fat by the Babcock method. Compare the per cent of solids obtained by the gravimetric method, with the per cent of solids calculated by applying different formulas.

2. Heat the silica dish containing the residue from No. 1 in the muffle to an ash. Cool in the dessicator, reweigh, and determine the per cent of ash in the milk.

What conclusions do you draw in No. 1?

1. Test in duplicate a sample of milk and cream for per cent of butter fat by the Babcock method. If the fat column in the completed test is not a clear, straw color, with sharply defined lines, the test must be repeated. Compare the results of this method with the results you obtained by the following modification of the Leffman-Beam method.

2. MODIFIED LEEFMAN-BEAM METHOD:

Test for per cent of fat in Milk: Prepare the sample of milk and measure the charge by following the Babcock method up to the point of adding sulphuric acid. Then proceed as follows:

1. Add 3 cc. of a mixture of Amyl alcohol and Hydrochloric acid (equal parts of Amyl alcohol and Hydrochloric acid).

2. Add 12 cc. of Sulphuric acid cautiously, mix and let stand for 3 minutes or until all the protein is dissolved and fat has risen to the top.

3. Add to top of graduation on neck of bottle a mixture of hot and freshly made solution of equal parts of sulphuric acid and water. NOTE: In making the solution, add the acid to the water.

4. Whirl in centrifuge at the usual speed of Babcock test for 5 minutes.

Reading the Test: Make three readings of the fat column.

1. From bottom of fat column to bottom of top meniscus.
2. From bottom of fat column to middle of top meniscus.
3. From bottom of fat column to top of meniscus.

Record all results.

Test for per cent of fat in Cream: Prepare the sample of cream same as for Babcock test, and weigh 9 grams of the sample into a 9-gram cream test bottle, adding 9 cc. of water. Complete the test by following the method given for milk with the exception of adding a little less sulphuric acid.

Reading the Test: Temper the cream test in water bath at a temperature of 130°—140° F. for 3 to 5 minutes. Make the following readings and record each:

1. Bottom of fat column to bottom of top meniscus.
2. Bottom of fat column to middle of top meniscus.
3. Bottom of fat column to top of meniscus.
4. Add meniscus remover and read from bottom of fat column to the sharp line at the junction of meniscus remover and fat column.

The official chemical results of this experiment will be given out at the close of the laboratory period.

Enumerate and describe the desirable and undesirable features of each method in this exercise. Include a tabulated form of all results.

QUESTIONS

1. How do the percentages of solids not fat and total solids of milk as determined by the chemical method compare with those obtained by the use of the different formulae?

2. Why should ash determinations be made in a muffle?

3. What is the purpose of adding the mixture of amyl alcohol and hydrochloric acid in the Leffman-Beam method of testing milk for fat?

4. How does this test compare with the regular Babcock test?

EXERCISE XXXVII

HART AND WALKER CASEIN TESTS, GERBER FAT TEST,
DETERMINING THE SOLUBILITY OF CASEIN.

1. Walker Casein Test. Titrate 9 c. c. of sweet milk in a white cup for per cent of acid using N/10 alkali solution. Use 1 c. c. of a 1% phenolphthalein solution as indicator. Stir constantly with a glass rod during the titration, and titrate to a fairly deep pink color. Then add 2 c. c. of neutral 40% formaldehyde solution. Take the reading on the burette and again run in, with constant stirring, the alkaline solution until the same degree of pink color again develops. The number of cc. of tenth normal solution used for the final titration multiplied by 1.63 gives the per cent of casein in the milk. Set aside some of the milk until the next exercise and again test it to determine if one may use this test for the per cent of casein in sour milk.

2. Test a sample of milk for fat by the Gerber method and compare the results with a test made by the Babcock method.

3. The Hart Casein Test: Place 2 c. c. of chloroform in the casein test tube, add 20 c. c. of a 0.25% solution of acetic acid at a temperature of 65 to 75° F. (10 cc. of glacial acetic acid diluted to 100 with water then diluting 25cc. of this solution to 1000cc.) 5 cc. of milk at a temperature of 65 to 75° F is then run in, the tube covered with the thumb and inverted and the mixture shaken vigorously for exactly 20 seconds, centrifuge within 20 minutes at a speed of 2000 revolutions per minute. Allow to stand ten minutes before reading the per cent of casein. Check the results by the Walker method.

EXERCISE XXXVIII

4. TESTING CASEIN FOR SOLUBILITY AND ADHESIVE PROPERTIES

4. Dahlberg Method: Place 50 grams of the powdered casein in a flask, beaker or dish, add about 100 cc. of water, measuring the amount. Mix the water and casein thoroughly. In another vessel place 5 grams of borax and add 75 cc. of water to it. Heat the water and mix until borax is dissolved. Pour the borax solution on the casein mixture and add water to bring the volume of the mixture to for quite a long time (30 to 60 minutes) with stirring until all casein is in complete solution. (Sometimes 2 c. c. of concentrated NH_3 are added to the mixture to assist solution but it is not usually added.) Then take 100 grams of Kaolin, (china clay) add 60-70 c. c. of water and work to a smooth heavy paste. To all of this Kaolin mixture add 30 grams of the casein mixture (6 grams of the casein) and thoroughly mix by use of a large spoon or similar instrument in a 3 pint bowl until the paste is very smooth. May also use brush in mixing. Then by using the brush transfer some of the mixture to a piece of brass, spreading it along a straight edge. Then spread the mixture without delay evenly on paper by holding the brass in a slanting position and pressing the mixture into the paper. The brass should be drawn across the paper with a quick motion. To the portion of the Kaolin-casein-borax mixture that remains add 5 grams more of the casein-borax mixture, mix it thoroughly and spread on paper as before.

Then make one more mixture by adding 5 more grams of the casein-borax-water solution and again spread on paper and let dry.

Test each mixture for adhesive properties by heating the end of a rod of wax till soft, then sticking it on the paper.

When cool pull the wax off. The mixture which gives the best results is the proportions that should be used in making the sizing. The best results are indicated by the amount of paper that sticks to the wax and fiber that is pulled up from the paper. The wax should be pulled off perpendicular to the paper. And the more shreds of paper and solid paper substances that sticks to the wax the better the quality of the casein.

QUESTIONS

For Walker Casein Test, read article in *Journal of Industrial & Engineering Chemistry*, Feb. 1914, p. 131.

Make a drawing of the Gerber milk test bottle.

What is your opinion of Gerber method as compared with Babcock method?

Explain why the per cent of fat may be read directly in the Gerber milk test bottle.

What is the purpose of the different reagents used in the Hart Casein test?

Why is borax used in the Casein Solubility test?

EXERCISE XXXIX

DETECTING BUTTER SUBSTITUTES

1. Melt samples of the butter substitutes in large test tubes two-thirds full. Keep at a temperature of about 150°F , until well melted and most of the casein and water have separated. Note any differences in transparency of the melted fat, when compared with the melted fat from pure butter.

2. Over a flame about an inch high from an alcohol lamp, gas jet, or kerosene lamp, heat in a teaspoon a quantity of the substance about the size of a chestnut. Heat slowly until melted, then rapidly until the water is nearly boiled off. Note any differences in the amount of foam formed and the length of time elapsing before the bubbles of foam break, when compared with pure butter heated in the same manner.

3. Fill a pint tin cup half full of skimmed milk, and heat nearly to boiling. Place a piece of the sample about the size of a butternut in the hot milk. Set the cup in a pan of ice water, and stir briskly by a rotary motion with a small wooden splinter a little longer than a match in diameter. When the fat begins to harden, it may readily be gathered into a mass at the center or in a lump on the end of the splinter if it is oleo. Butter fat or renovated butter will not gather so readily, but will float on the surface spread out quite uniformly.

4. Halpen's Test for Cotton-Seed Oil: To 3 cc. of the oil or melted and filtered fat in a small test tube, add 3 c. c. of amyl alcohol and 3 c. c. of a one per cent solution of sulphur in carbon disulphide. Heat the test tube in a boiling salt saturated water solution for 10 or fifteen minutes. If cottonseed oil is present, the mixture turns red.

EXERCISES XL—XLI

REICHERT-MEISSEL NUMBER OF BUTTER AND OLEOMARGARINE,
AND MAKING VISCOGEN

1. Melt about 30 grams of the substance in a test tube, at a temperature of about 140°F. and hold at this temperature until the water and casein have separated. Filter the liquid fat through a dry filter with funnel inserted into a convenient Erlenmeyer flask; keep warm in the 100°C. oven to assist the filtration process. Measure 5.75 c. c. of the filtered fat into a weighed 300 c. c. Erlenmeyer flask that has been thoroly cleaned and dried in the water oven. Cool and weigh to get the amount of fat taken; saponify the fat adding 20 c. c. of a soda glycerine solution (20 c. c. of 50% solution of sodium hydroxide in 180 c. c. of glycerine), heating the flask in the 100°C. oven, or over a bunsen flame. The solution is perfectly clear when saponification is complete. Then add 135 c. c. of water, drop by drop at first, to prevent foaming. A pinch of pumice stone powder is added, and 5 c. c. of dilute sulphuric acid solution (20 c.c. of Conc. H_2SO_4 + 80 c.c. of distilled water.) Connect the flask to the condenser, using distilling connecting bulb, and distill over 110 c. c. of the volatile fatty acids. Mix the distillate, and if not perfectly clear, filter. Titrate 100 c.c. of the distillate with N/10 NaOH, using phenolphthalein as indicator, and increase the number of c. c. of N/10 NaOH required, by one-tenth to obtain the Reichert-Meissl number.

2. Viscogen: Slake one ounce (28.35 gr.) of quick lime in sufficient hot water to nearly cover it, using a pint milk sample bottle. Mix during the slaking process. The substance should be in a pasty condition when slaked. Add 150 c. c. of cold water. Dissolve 3 oz. of sugar in 150 cc. of water, and mix it thoroughly with the slaked lime solution. Mix at intervals for a few hours. Let settle and use the clear solution at the next exercise.

Note: Viscogen may be made in large quantities for commercial purposes by slaking 3 pounds of good quick lime in water. Make the volume up to 5 gallons by adding water. Dissolve 10 lbs. of sugar in 5 gallons of water. Mix the two solutions and stir at intervals for 3 hours. Let settle and use the clear solution.

3. Determine the alkalinity of the viscogen made in 3. Make an acid test of a sample of cream and add a sufficient amount of viscogen to 25 cc. of the cream to just neutralize the acid. Determine the viscosity of the visco-cream and the original cream by comparing the distance that drops of equal size from each will flow on an inclined glass plate.

QUESTIONS

1. Make a drawing of the distilling apparatus used in determining the Reichert-Meissl number.
2. Give the variations and average Reichert-Meissl number and refractive index of butter and oleomargarine.
3. What is viscogen and for what is it used?

EXERCISES XLII—XLIII

MODIFYING MILK FOR INFANTS AND INVALIDS

Cream, skim-milk, milk sugar and water are mixed to obtain the desired percentages.

Factors used in formulas:

A = the percentage of fat in the cream

B = the percentage of proteids in the skim-milk

C = the ounces of cream required

D = the ounces of sugar required

E = the percentage of sugar in the cream

F = the desired percentage of fat

M = the ounces of skim-milk required

N = the percentage of sugar in the skim-milk

P = the desired percentage of proteids

Q = the ounces of modified milk desired

R = the percentage of proteids in the cream

S = the desired percentage of sugar

W = the ounces of water required

Problem: Make up 24 ounces of modified milk containing 3.5% fat 1.25% proteids and 5% milk sugar.

Materials available for use:

Cream containing 18% fat, 3.0% proteids, 4.0% sugar

Skim-milk " 3.5% " 5.0% "

Milk sugar, 100% lactose

Calculating the ounces of cream required:

$$C = \frac{(F \times Q)}{A}$$

Calculating the ounces of skim-milk required:

$$M = \frac{(Q \times P) - (C \times R)}{B}$$

Calculating the ounces of milk sugar required:

$$D = (Q \times S) - [(C \times E) + (M \times N)]$$

Calculating the ounces of water required:

$$W = Q - (C + M + D)$$

In addition to the problem given above another will be

given to each student. The mixtures are to be made up and tested for fat and total solids on the Mojonnier tester.

QUESTIONS

1. What is modified milk and for what purpose is it generally used?
2. What are three general methods of modifying milk?
3. How is the percentage of each solid not fat in cream affected by an increase in the percentage of fat?
4. If a sample of whole milk contained 4% of fat and 3.7% of protein, what percentage of protein would be found in cream containing 40% of fat made by separating the milk?

EXERCISES XLIV—XLV

METHOD OF TESTING UNSWEETENED EVAPORATED MILK:

The sample is mixed by shaking, pouring and stirring. Examine the surface closely and if fat particles are observed, warm the mixture to 100°F. and again mix.

Fat Test: Weigh 9 grams of the sample mixed as above into a Babcock milk test bottle. Add 9 c.c. of water and shake to mix thoroughly. Add about 17.5 c. c. of sulphuric acid. Mix thoroughly, then add about 2 c. c. more of the acid, and shake vigorously for two or three minutes. Complete the test as for whole milk. The fat reading multiplied by 2 gives the per cent of fat.

METHOD OF TESTING SWEETENED CONDENSED MILK FOR PER CENT OF FAT.

Mix thoroughly by transferring the contents of the can into a convenient dish and stirring until homogeneous. Weigh out 40 grams and wash it into a 100 c. c. flask and make up to the mark with water, or the 40 grams may be weighed directly into the flask before making up to the 100 c. c. mark.

Place 15 c. c. of this 40% solution in a Babcock milk test bottle. Fill the bottle nearly to the neck with water, add 4 c. c. of Fehling's solution, shake thoroughly and rapidly, centrifuge, preferably in a cold machine. The casein and fat are thrown to the bottom. Withdraw the supernatant liquid by means of small-stemmed pipette with a wisp of wet absorbent cotton twisted over the tip to serve as a filter. Wipe off the cotton into the bottle on withdrawing the pipette. Give the precipitated proteids and fat two additional washings by shaking up with water, again centrifuging and removing the water each time with the pipette. If the precipitate is caked hard after centrifuging, it must be broken up by using a fine wire stirrer. Finally, add water to an approximate volume of 17.5 cc. and add 17.5 cc. of Babcock sulphuric acid and complete the test as for milk. The reading multiplied by 3 gives the per cent of fat in the sample.

Note: Fehling's copper solution = 34.639 grams of pure copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) dissolved in water and diluted to exactly 500 c.c.

TESTING ICE CREAM FOR BUTTER FAT: METHOD BY
A. W. RUDNICK.

Weigh out 9 grams of the freshly melted and mixed sample in a 9-gram, 6-inch, 50% cream test bottle. Add 9 c. c. of dilute sulphuric acid (1 of acid to 3 of water) saturated with ammonium sulphate, and centrifuge for 5 minutes at a little higher speed than for ordinary testing. Pour off or draw off the liquid by means of a pipette. Add 9 c. c. of water and proceed as in the cream test.

If nuts or fruit have been used, these should be ground very fine, preferably by means of a mortar and pestle, and the fat column brought into the neck by using denatured alcohol instead of water. Read the fat column in this case from the extreme bottom to the extreme top.

METHOD OF PROF. H. E. ROSS FOR TESTING ICE CREAM

Mix equal parts by weight of the melted ice cream and water. The water should be at a temperature of about 100°F. and the mixing is best done by pouring the mixture from one vessel to another. Weigh into a cream bottle 9 grams of the mixture. A 9-gram cream bottle with a body the size of an 18-gram cream bottle is best, although a regular 18-gram cream bottle may be used. To the 9 grams of the mixture add 17.5 c. c. of the glacial acetic acid. Thoroughly mix the acid and cream by shaking the bottle from two to three minutes. Next add 15 cc. of sulphuric acid such as is commonly used for the Babcock test. Thoroughly mix the contents of the bottle by shaking about a minute. Then proceed with the test in the ordinary way. If a 9-gram bottle is used, the result should be multiplied by 2 as the cream was diluted one-half. If an 18-gram cream bottle was used, the result should be multiplied by four, as the cream was diluted one-half and one-half the regular amount was used for the test.

METHOD OF J. P. DAWSON FOR TESTING ICE CREAM

Weigh 18 grams of melted ice cream at a temperature of 70°F. into a 30%, 9-inch cream test bottle. Add 8 c. c. of glacial acetic acid, agitate gently for 2 minutes, and add 10 c. c. of sulphuric

acid. Shake thoroughly and centrifuge and complete the test in the usual manner for ordinary cream.

Note: There appears to be no reason why the above described method would not work equally well using 9 grams of the ice cream and an 8-inch 50% 9-gram cream test bottle, and adding only one-half the volume of acids.

EXERCISES XLVI—XLVII

TESTS FOR PRESERVATIVES AND ADULTERANTS,
TESTS FOR BOILED MILK

To 10 or 15 cc. of milk in a test tube or bottle add an amount of calcium peroxide the size of a kernel of wheat, shake and add the same amount of paraphenylenediamine-hydrochloride. Again shake the mixture and if the milk was not boiled or heated above 175°F. it will develop a blue color in a few minutes.

SECOND TEST FOR BOILED MILK

Add one c.c. of a slightly pasty starch solution that was made by boiling starch in water, to 10 or 15 cc. of milk in a test tube or bottle, next add 5 to 6 drops of a 10% solution of potassium iodide and finally a pinch of calcium peroxide the size of a kernel of wheat and shake. A blue color will develop in a few minutes if the milk has not been heated above 175°F.

TEST FOR MYSTIN (A COMPOUND OR MIXTURE OF FORMALDEHYDE AND A NITRITE.)

Five cc. of milk or cream are mixed with 5 cc. of water and to it are added 0.5 cc. of a 10% solution of urea, then 1 cc. of normal (N/1) sulphuric acid and the mixture heated in boiling water for two minutes. Cool and add 2 or 3 drops of a 10% solution of ferric chloride. Then add 5 cc. H_2SO_4 , Sp. Gr. 1.82. Do not mix. In the presence of formaldehyde a blue color will form where the acid comes in contact with the lower surface of the milk.

TEST FOR SODIUM CARBONATE IN MILK OR CREAM

To ten cc. of the milk or cream add 10 cc. of alcohol and a few drops of a 1% solution of rosolic acid. Carbonates are present if a rose red color appears. Pure milk may give a brownish yellow color.

TEST FOR STARCH IN DAIRY PRODUCTS

Add to a few cc. of the milk or other product in a test tube or vial a drop of iodine solution. A blue color shows the presence of starch. Dried milk products should be boiled in about 10 times their weight of water and cooled before adding the iodine solution.

TEST FOR BORATES IN MILK OR CREAM

To about 10 cc. of milk in a porcelain dish, add lime water until the milk is alkaline. Evaporate the water off and burn to an ash. Add two or three drops of hydrochloric acid and a few of drops of water. Place a strip of tumeric paper in the solution, allowing one end to extend up over the edge of the porcelain dish. Again evaporate to dryness at a temperature not above the boiling point of water. If either borax or boric acid were present in the milk, the tumeric paper will change to a cherry-red color. A drop of ammonia placed on the cherry-red paper gives an olive-green color.

In testing butter for borax or boric acid, some of the butter should be melted and the water and casein allowed to settle. Then take 3 or 4 c. c. of the mixture of water and casein that has settled at the bottom and proceed with the test as with milk.

TEST FOR SALICYLIC ACID AND SALICYLATES

Twenty cc. of the milk are acidulated with sulphuric acid and shaken with ether; the ether solution poured off and evaporated, and the residue treated with alcohol and a little iron-chlorid solution. A deep violet color will develop in the presence of salicylic acid.

TEST FOR SUCROSE IN MILK OR CREAM

Ten cc. of the sample are mixed with 0.5 gram of powdered ammonium molybdate, and 10 cc. of dilute hydrochloric acid (1 to 10) added. In a second tube 10 cc. of milk of known purity are similarly treated. The tubes are then placed in the water bath at a temperature of 80°C. An intense blue color develops in the presence of sucrose. One-tenth of one per cent of sucrose gives a well marked reaction. If the temperature is raised too high pure milk may give a color.

TEST FOR SACCHARATE OF LIME OR SUCROSE IN MILK OR CREAM

To 10 cc. of the milk or cream in a test-tube add 0.5 cc. of strong hydrochloric acid and 0.1 gram of resorcinol dissolved in 5 cc. of water. Shake and place the mixture in boiling water for five minutes, when a pink to deep red color gradually develops in the presence of saccharate of lime. Pure cream turns yellowish or brown. This test does not prove the presence of added lime as it is primarily a test for cane sugar.

TEST FOR GELATIN

Dissolve one part by weight of mercury in 2 parts by weight of concentrated C. P. nitric acid (sp. gr. 1.42) and add 24 times its volume of water. Place 10 cc. of this solution in a test tube, together with an equal volume of cream. Shake well and add 20 cc. of water. Shake again, let stand 5 minutes and filter. If much gelatin is present the filtered liquid will be cloudy or opalescent. To a little of this liquid in a test tube add an equal amount of saturated solution of picric acid. If the solution remains perfectly clear gelatin is absent. Small amounts of gelatin give a cloudiness, larger amounts a yellow precipitate upon adding the picric acid.

TESTS FOR AGAR-AGAR IN CREAM

About 50 grams of cream are diluted with 100 c.c. of water and the container with contents heated in boiling water and cleared by the addition of 10% calcium chloride solution. The mixture is filtered clear preferably in a hot water funnel, cooled, and from one-half to two-thirds of its volume of strong alcohol added. The precipitate is filtered off and boiled with a small quantity of water till no more dissolves, filtered and evaporated down to 5 cc. when the solution will gelatinize in the presence of agar-agar.

Also if gelatin is suspected of being present, before evaporating down to 5cc. in the above test, add saturated picric acid solution to some of the filtrate when a turbidity or precipitate is produced if gelatin is present. In that case the remainder of the filtrate is evaporated to 25 cc. and a 10% solution of tannin added, until a precipitate ceases to form. To the mixture which must be under 60° C. are added 5 to 10 cc. of white of egg and the whole heated in boiling water for 30 minutes. The solution is filtered hot and concentrated on the water bath to a small bulk, when the presence of agar-agar is indicated by gelatinization.

TEST FOR FLUORIDES

50 grams of milk or cream are made just alkaline with sodium carbonate and rapidly boiled down in a platinum dish, the fat poured off and the residue burned nearly white. The residue is moistened with a few drops of Conc. sulphuric acid, and the dish covered with a waxed watch-glass having some marks scratched

through the wax, is heated on a hot plate (80° C.) for half an hour, the watch glass being filled with water or ice as necessary. After removal of the wax the glass is examined for etching along the lines scratched through the wax.

LIST OF BULLETINS

- Cir. 234 Operation of the Cream Receiving Station.
By N. W. Hepburn and H. A. Ruehe
Cir. 42 Testing Milk and Cream for Butter Fat
By O. F. Hunziker
Bull. 166 Chemical Changes Produced in Cow's Milk by Pasteurization. By Philip Rupp, M.D. Ph.D. Dairy Div.
Composition of Milk and Some of its Products
By H. E. Ross
R. C. Lesson 32 A Comparison of the Acid Test and The Rennet Test
Vol. II for Determining the Condition of Milk for the Cheddar
Cir. 210 Type of Cheese. By E. G. Hastings, and Alice C. Evans
Distribution of Moisture and Salt in Butter.
By E. S. Guthrie and H. E. Ross.
Bull. 336 A Modification of the Babcock Test as Applied to
the Estimation of Fat in Desiccated Milk.
By N. Gregory Redmond
Bull. 281 Butter Moisture—Tests By H. E. Ross
Tech. Bull. 14 The Fermentation of Citric Acid in Milk.
By Alfred W. Bosworth and M. J. Prucha
Bull. No. 143 Standards for Evaporated Milk, Sweetened Condensed
Vol. XV Milk and Condensed Skim-milk. By O. F. Hunziker
Tech. Bull. 10 A Volumetric Method for the Determination of Casein
in Milk. By L. L. VanSlyke and Alfred W. Bosworth
Bull. 134 1909 The Estimation of Fat in Unsweetened Evaporated
Milk. By O. F. Hunziker and G. W. Spitzer
Bull. 222 Record of An Attempt to Increase the Fat in Milk
by Menas of Liberal Feeding.
By Henry H. Wing and James A. Foord
Research Bull. 41 A Rapid Volumetric Method for Approximate Estimation
of Chlorine in Milk.
By B. W. Hammer and D. E. Bailey.
Bull. 177 Butterfat Losses in Creameries
By R. M. Washburn and A. C. Dahlberg and James
Sorenson and M. P. Mortensen.
Cir. of information 41 The Milk Sediment Test and Its Applications.
By A. C. Baer
- Urbana, Illinois, March, 1919.
Purdue Univ. LaFayette, Ind., January, 1914
Wash., D. C., 1913
Ithaca, N. Y., Jan. 15, 1913.
U. S. Dept. of Agri., Wash., D. C., 1913
Ithaca, N. Y., Oct., 1913.
Reprinted from the Journal of Industrial and
Engineering Chemistry, Vol. 4, No. 7. July, 1912
Ithaca, N. Y. August, 1910
Geneva, N. Y. Nov., 1910.
LaFayette, Ind. May, 1910
Geneva, N. Y. Sept., 1909.
Ind. Agr. Exp. Station
Ithaca, N. Y. Sept., 1904.
Ames, Iowa. June, 1917
University Farm, St. Paul, Minn. Sept., 1918
Madison, Wisconsin. Sept., 1912.

- Cir. of Information 32 The "Coming of Age" of the Babcock Test.
By H. L. Russell Madison, Wisconsin. March, 1912
- Bull. 152 Testing and Handling Dairy Products.
By Dairy Husbandry Department Brookings, South Dakota. Aug., 1914.
- Bull. 197 Methods of Paying for Milk at Cheese Factor's.
By S. M. Babcock, E. H. Farrington and E. B. Hart Madison, Wis. July, 1910
Experiment Station Work Wash., D. C. Feb. 3, 1912.
- Bull. 167 Mitchell-Walker Moisture Test.
By J. W. Mitchell and W. O. Walker Ontario Dept. of Agriculture, Kingston, Ont.
Oct., 1908.
- Translation from Zeitschrift für Untersuchung der Nahrungs und Genussmittel 1912 By C. Mai and E. Rheinberger The Hague. Van Langenhuyzen Brothers, 1913.
- Bull. 94 Variations in the Fat, Solids-Not-Fat, and Total Solids in Cow's Milk.
Storrs, Conn. Jan., 1918
- Cir. 41 By George C. White and Henry F. Judkins Licenses for Creameries and Testers Laws, Rules and LaFayette, Ind. Sept., 1913.
- Bull. 241 Regulations. By O. F. Hunziker.
Some Improved Dairy Tests and Methods.
By G. H. Benkendorf, A. T. Bruhn, A. C. Baer and J. L. Sammis. Madison, Wisconsin, July, 1914.
- Bull. 177 Butterfat Losses in Creameries.
By R. M. Washburn and A. C. Dahlberg and James Sorenson and M. P. Mortensen. University Farm, St. Paul, Minn. Sept., 1918
- Cir. 78 Testing Milk and Cream for Butter-Fat.
By R. E. Caldwell, T. H. Broughton and S. L. Anderson. LaFayette, Ind. Feb. 1918
- College Bull. 201 Babcock Test and Users of Babcock Glassware.
By Edward B. Fitts Oregon Agricultural College, Corvallis, Oregon.
Nov. 27, 1909.
- Cir. 32 Testing Milk and Cream. Ames, Iowa. Dec., 1916
- Bull. 189, Vol XIX Cream Testing Balances. LaFayette, Indiana. July, 1916
- Bull. 337 The Babcock Test with Special Reference to Testing Cream. By H. E. Ross and T. J. McInerney. Ithaca, N. Y. Oct., 1913

- Book
 Questions and Answers on Milk and Milk Testing.
 By Publow and Troy.
- Bull. 58
 The Fat Testing of Cream by the Babcock Method.
 By Ed. H. Webster and C. E. Gray.
- R. C. Lesson 140
 The Babcock Test, and Testing Problems.
 By H. C. Troy.
- Bull. 145 Vol XV
 Testing Cream for Butter Fat.
- Bull. 145 Vol XV
 Testing Cream for Butter Fat.
- Bull. 195
 New and Improved Tests of Dairy Products.
 By S. M. Babcock and E. H. Farrington.
 The Preparation of Buttermilk Curd.
 By J. L. Sammis.
- Bull. 154
 A Creamery Method for the Determination of Water
 in Butter. By E. H. Farrington.
- Cir. 64
 Directions for Testing Cream.
 By L. G. Rinkle
 The Mojonnier Tester
- An Investigation to Determine the Accuracy of a
 Modified Meigs Method for the Quantitative Deter-
 mination of Fat in Milk, with a Description of an
 Improved Form of Apparatus. By Walter Lewis Croll
 Rules for Calculating the Approximate Composition
 of Milk from the Specific Gravity and Percentage of
 Fat as Determined by the Babcock Method.
 By H. I. Bowditch, M.D., and A. W. Bosworth, A.M.
 Dairy Laboratory Manual and Notebook.
 By Ernest L. Anthony, B. S. A.
- Journal of American
 Dairy Science Assoc.
 Vol. I No. 1
 May, 1917
- U. S. Department of Agriculture, Bureau of Ani-
 mal Industry, Wash., D. C. 1904
- Ithaca, N. Y. Nov., 1916.
- LaFayette, Indiana, June, 1910
- LaFayette, Indiana, Oct., 1910
- Madison, Wisconsin, Sept., 1912.
- Madison, Wisconsin. Sept., 1907
- Columbia, Missouri. July, 1913
- Mojonnier Bros. Co.
 549 W. Washington Boulevard, Chicago, Ill.
 Madison, Wisconsin. Sept., 1912
 Reprinted from the Biochemical Bulletin, Vol II,
 No. 8. July, 1913.
- Reprinted from the American Journal of Diseases
 of Children. March, 1914, vol. vii, pp. 244 and 245
- Pa. State College.

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